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ACCOMPLISHING SHIPYARD WORK FOR THE UNITED STATES NAVY: INSTITUTIONS, SYSTEMS AND OPERATIONS

VOLUME 1: BASIC REPORT

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August 1975

INSTITUTE FOR DEFENSE ANALYSES
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This study examines factors relating to accomplishment of Navy ship workloads in naval and private shipyards. It was designed to present, in a single document, a comprehensive discussion and evaluation of information from a wide range of areas that impact on the accomplishment of Navy workloads. This volume

The results of the study are presented in three volumes. Volume 1 (the basic report) examines facilities, organizations and manpower skills

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required for ship construction versus depot maintenance in both naval and private shipyards; Navy procedures for placing shipyard work; shipyard performance indicators; and the labor market for the shipbuilding and repair industry. The volume concludes with recommendations to improve the cost-effectiveness of performance of shipyard work and identifies several key areas for further study. Volume 2 is a compilation of appendixes containing additional material to support the basic report. Volume 3 is an annotated bibliography covering 150 documents related to subjects covered by this study.

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EXECUTIVE SUMMARY

A. THE INSTITUTE FOR DEFENSE ANALYSES TASK

This study, undertaken at the request of the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation, comprises comprehensive analyses of cost and institutional factors relating to the performance of Navy ship workloads in private and naval shipyards. The study considers some factors related to ship new construction, but the major emphasis is on ship depot maintenance.

The study addresses the following specific subject areas:

(1) Differences in facilities, organizations, and manpower skills required for ship construction versus depot maintenance in typical naval and private shipyards.

(2) The impact on Navy ship depot maintenance programs of Navy procedures for placing ship depot maintenance work in naval and private shipyards.

(3) The validity of performance indicators, including productive ratios, as measures of shipyard performance.

(4) Major factors that influence overhead rates.

(5) The characteristics of the shipyard labor market and the capability of the shipbuilding and repair industry to obtain sufficient manpower to fulfill projected future requirements.

(6) The effect of shipyard industrial factors on shipyard costs and capabilities to respond to varying workload magnitude and mix.

(7) Possible actions available to DoD to improve the cost-effectiveness of the performance of shipyard work.

B. BACKGROUND

In fiscal year 1975, the United States Navy budget included about $3.8 billion to procure new ships and $1.8 billion to convert, alter, and repair active and reserve fleet ships in naval and private shipyards. These funds accounted for 22 percent of the total Navy FY 1975 budget. Table S-1 contains a summary of these Navy ship programs from FY 1972 through FY 1976. Data are in current year dollars and were not normalized to remove effects of inflation during the period. Data for FY 1972 through FY 1974 show actual expenditures; for FY 1975 and FY 1976 the data are based on the applicable fiscal year budget.

Since FY 1966 the Navy has contracted with private industry for the construction of all new ships. Private industry also performs roughly 30 percent of the Navy's depot maintenance work. The eight naval shipyards are engaged exclusively in depot maintenance, but four of the yards currently have some capability to build new ships, if required.

In terms of total business, the value of work done in U.S. private shipyards in calendar year 1974 was $1,840 million for the U.S. Navy and $2,200 million for commercial customers. In FY 1975 the naval shipyards produced goods and services valued at $1,155 million. In March 1975, the U.S. shipbuilding and repair industry employed about 157,000 personnel in private shipyards and 62,000 in naval shipyards.

The Department of Commerce lists about 257 private shipbuilding and repair activities in the United States; 188 of those yards hold Master Ship Repair Contracts (MSRCs) with the Navy and, therefore, are eligible to perform Navy depot maintenance shipwork.[1] Comparatively few of the private shipyards

[1]Master Ship Repair Contracts are awarded to shipyards applying for those contracts only after the Navy has determined that the private shipyard has a capability to perform ship repair work.

Table S-1. NAVY SHIP NEW CONSTRUCTION AND DEPOT MAINTENANCE PROGRAMS, FY 1972-1976

(in millions of current year dollars)

Programs	FY 72	FY 73	FY 74	FY 75	FY 76
1. Ship New Construction	1,998	1,505	3,588	3,810	5,499
2. Ship Conversion, Alteration, and Repair	1,422	1,670	1,753	1,808	1,974
3. Total Ship Programs	3,420	3,175	5,341	5,618	7,473
4. Total All Navy Programs	22,034	23,123	24,477	25,623	30,981
5. Line 3 ÷ 4	16%	14%	22%	22%	24%

perform almost all of the Navy ship repair work placed in the private sector. About 43 percent of the alteration and repair funds expended in the private sector went to five shipyards in FY-74. Very few of the private shipyards have the manpower, equipment, and facilities to perform depot maintenance on complex Navy combatant ships.

In FY-74, almost 93 percent of the funds paid to private shipyards for Navy ship new construction and conversion went to three private shipyards. This concentration of work resulted from the requirement that all new major Navy ships must be nuclear powered, and only three private shipyards have the requisite capability to build those ships.

The United States has always placed a high priority on the need for a strong Navy and Merchant Marine. Strong fleets of ships are dependent upon healthy, viable shipbuilding and repair industries; therefore, this industry has been the subject of attention quite disproportionate to its size in relation to other industries.

The United States has experienced special problems in maintaining a shipbuilding and repair industry adequate to meet the country's existing and potential requirements. Many Navy shipbuilding and repair programs have exhibited the "feast or famine" characteristics that often plague military programs. Shipbuilding and repair support for commercial requirements has suffered from the high cost of labor in the United States, as compared with other countries, and the inability of the industry to offset higher costs with greater productivity.

In recent years, several developments have caused increased attention to be focused on the U.S. shipbuilding and repair industry. Some of the major developments were:

(1) A reduction in the size of the U.S. Navy with the total number of ships declining from 976 in 1968 to 497 on 30 June 1975.

(2) A steady decline in the size of the U.S. Merchant Marine with ever-increasing percentages of U.S. cargoes being carried by foreign-registered ships.

(3) The construction of limited numbers of commercial ships in U.S. shipyards, prior to 1970.

(4) The passage of the Merchant Marine Act of 1970, which made the U.S. maritime industry more competitive.

In addition to these major developments, other changes have occurred that are more limited in scope but affect the shipbuilding and repair industry and relationships between the private sector of that industry and the U.S. Navy. Among these developments were:

(1) Changes, since 1960, in Navy procurement policies relating both to ship new construction and repair.

(2) Changes in ownership and control of shipyards in the private sector of the industry.

(3) The DoD decision in 1966 to place all new ship construction in private shipyards.

(4) The severe inflation in the United States since 1969.

(5) The increase in Naval ship size (dimensions and displacement) and complexity with resulting higher procurement and repair costs.

As a result of all these developments, many federal government agencies have undertaken studies of the U.S. shipbuilding and repair industry. This paper presents the results of an IDA study designed to aid the Department of Defense in developing program and fiscal guidance for U.S. Navy shipyard work.

C. SIGNIFICANT FACTS

Significant facts derived from the analyses conducted in this study are summarized below. To facilitate reference to the supporting analyses in the basic report, references are included to the sections of Volume 1 from which the facts are drawn.

<u>Organization (Chapter II.A)</u>

- Naval shipyards are structured under a standard organization prescribed by Naval Sea Systems Command (NAVSEA), but private shipyards exhibit considerable diversity of organization.
- Naval shipyards currently perform only ship depot maintenance work; private shipyards vary from those that perform only limited repair to those that do complex repair and new construction work.
- Naval shipyards have organizations to perform practically all functions associated with ship depot maintenance; private shipyards often have more limited inhouse capabilities to perform such specialized functions as design and engineering and make more extensive use of subcontractors.

- Naval shipyards licensed to perform nuclear work have, in addition to the basic NAVSEA organizational structure, component organizations to perform exclusive nuclear-oriented functions; heads of these components have direct access to top-level shipyard management.

Facilities (Chapter II.B)

- Naval shipyards all are large industrial complexes with extensive facilities and large amounts of industrial plant equipment; facilities range from obsolescent to very modern. Naval shipyards can perform practically all functions required for ship repair and overhaul.
- Private shipyards are very dissimilar in size, ranging from the largest shipyard in the United States to very small, specialized repair activities. There is also a wide variation in the capability of private shipyards to accomplish Navy work.
- In terms of facilities, private shipyards range from modern yards employing the latest technology for ship construction and repair to small yards possessing a mixture of new and old facilities and equipment.
- Four naval shipyards have some capability for ship new construction, but the last ship built was completed in April 1972. The Navy estimates that if ship new construction were to be resumed in naval shipyards, 18 to 24 months would be required from the date of program approval to the date when the first keel could be laid. The Navy further estimates that the additional facilities and equipment required would cost about $5.4 million, and that another $37 million should be expended to improve

efficiency if sustained new construction programs are to be undertaken.

- The Maritime Administration (MARAD) categorizes 25 private shipyards as major shipbuilding yards. In 1974, 6 of those yards were building ships for the Navy.

- NAVSEA estimates that 21 private shipyards have the facilities (drydocks, industrial equipment, and utilities) to perform overhauls on combatant ships as complex as those in the Forrest Sherman destroyer class; about 7 of those shipyards have the required levels of manpower with the specialized mix of skills to perform this work.

Manpower (Chapter II.C and Chapter VI)

- The shipbuilding and repair industry is labor intensive, both absolutely and relative to other manufacturing industries.

- With the exception of skills peculiar to the repair of combatant Navy ships, essentially the same manpower skills are employed in naval and private shipyards.

- The same basic skills are employed for new construction and for repair, although the mix of skills differs. Shipbuilding uses more skills in the structural trades, i.e., welding, shipfitting and sheetmetal work, whereas repair work requires more skills in the mechanical and electrical trades.

- Shipbuilding and repair is also a skill-intensive industry; 61 percent of the production workers employed in major yards are journeymen.

- Unlike workers in most other industries, shipyard workers in the same trades generally do not receive different wages based on skill. For example, all journeymen in the sheet-metal trade in a given private shipyard generally receive the same pay regardless of skill level or longevity.
- Wage rates in the shipbuilding and repair industry since 1961 have exceeded the U.S. average for all private non-agricultural employees, but the percentage advantage has been declining. Private shipyard wages, however, do not exceed wages for the majority of the jobs used in federal wage surveys to determine the prevailing wages in local private industry.
- An inverse relationship exists between real wages and quit rates in private shipyards.
- Quit rates in private shipyards typically exceed those in other durable goods manufacturing industries.
- The annual turnover rate among shipyard employees is four to five times higher in private shipyards than in naval yards.
- The shipbuilding and repair industry is expected to expand employment by about 5.2 percent in 1975[1] and remain level through 1976; based on historical experience and current economic conditions, these employment objectives should be readily attainable.

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[1]Based on projection by Office of Ship Production, NAVSEA, February 1975. Since this paper is being published subsequent to the end of calendar year 1975, IDA verified actual employment expansion in the private shipyard sector. The sector employment expanded 10.2 percent from 1 January 1975 to 31 December 1975.

- Virtually any sizable long-term increase in demand for shipwork will result in at least transitional shortages of skilled labor in some regions.

- The ease of expansion of shipyard employment varies by region and in an inverse relationship to the shipbuilding and repair industry's share of total regional employment. In areas in which shipyard employment is a significant part of total employment, increased shipyard employment may be more effectively pursued by policies designed to increase the total labor supply in the area rather than by increases in shipyard wages.

- Formal apprentice programs exist in all naval shipyards. Few private shipyards have similar programs and output from them is not adequate to support significant expansion in the industry. Based on a 1973 survey of 47 private shipyards, Mark Battle Associates reported that 12 of the private shipyards had formal apprentice programs. With the exception of the Bath, Electric Boat, and Newport News shipyards, these programs were limited to very few specialized occupations or to a relatively small number of participants.

- From 5 to 7 percent of the total work force in naval shipyards engaged in nuclear work is assigned to nuclear-dedicated offices (i.e., the Radiological Control Office, the Nuclear Engineering Department, and the Nuclear Inspection Division of the Quality Assurance Office). The total number of people required to perform tasks unique to the nuclear mission could not be determined from the data made available to IDA.

Placing Ship Depot Maintenance Work (Chapter III)

- About 18 months in advance of the start of the fiscal year in which the work will be performed, ships are scheduled for overhaul by hull number, by date of entry, and to a specific naval shipyard or appropriate Supervisor of Shipbuilding and Repair (SUPSHIP) for placement in the private sector.
- The workload of each ship to be overhauled is determined through the development of a Ship Alteration and Repair Package (SARP) during advance planning, which begins about a year prior to the start of the overhaul.
- The Planning and Engineering for Repairs and Alterations (PERA) offices centrally coordinate and, to some extent, manage advance planning for ship overhauls for NAVSEA ship logistic managers and commanders of operating fleets.
- Under present laws and the Armed Services Procurement Regulation (ASPR), the preferred method of procurement is by formal advertising whenever this method is feasible and practicable, even though the conditions and circumstances appear to satisfy the requirements for negotiation.
- Negotiated procurements, to the maximum practicable extent, must be made on a competitive basis and must meet the criteria of 1 of 17 exceptions to formal advertising provided in the U.S. Code.
- There are indications that split-bidding ship overhauls increases competition and, in many cases, results in more favorable prices.

Performance Indicators (Chapter IV)

- Generally accepted overall performance measures for industrial repair and overhaul activities, such as shipyards, do not exist because of difficulties in quantifying input and output.
- Depot maintenance output measures currently cannot be computed at the total shipyard level because of the job-shop nature of ship repair work.
- Generally accepted composite resource input measures do not exist because of the difficulty of measuring intangible inputs, such as work force skill, worker motivation, and the effectiveness of planning and supervision.
- Even though generally accepted performance measures do not exist, shipyard cost and labor data are available that permit the monitoring of changes in performance in terms of efficiency and effectiveness without measuring the level of performance in absolute terms.
- Productive ratios, defined as the relationship of direct labor to total labor in the shipyard, are occasionally considered reasonable measures of shipyard productivity. Productive ratios, however, are labor ratios and since labor is only one of many inputs required to produce a given output, these ratios are not objective measures of total productivity. On the other hand, since labor accounts for about 75 percent of naval shipyard costs, these ratios are useful in monitoring trends in the application of shipyard labor.
- Performance of naval shipyards may be monitored to some extent through the use of input indicators as

surrogate output measures (e.g., dollars per direct manday expended to accomplish shipwork).

- Labor and cost ratios are useful to identify trends, detailed analysis of which can determine causes and indicate actions available to management to influence future trends.
- Various ratios should be used as indicators of comparative performance among shipyards only if industrial characteristics, workloads, and management concepts are sufficiently consistent among the shipyards to permit comparisons.

Factors Influencing Cost (Chapter V)

- Important variables that influence total costs of shipyard work are:
  -- mission of the shipyards,
  -- work force-workload balance,
  -- amount of nuclear work performed.
- Naval shipyards are operated under the Navy Industrial Fund to permit "commercial type" producer-customer relationships.
- The total cost incurred by naval shipyards in accomplishing assigned workloads comprises 75 percent labor, 15 percent material, and 10 percent miscellaneous "other" costs.
- The Federal Wage System requires that wage survey teams, appointed on a temporary basis from federal agencies in each local wage area, collect data annually for jobs from many different industries. These data are used to establish the level of prevailing wages in each local area. Wage rates in private shipyards are generally lower than wages

for the majority of jobs included in the survey data base.

- The Federal Wage System requires that the step two wage rate for federal wage employees be established at the level of prevailing wages for selected jobs in local private industry. The majority of naval shipyard blue-collar workers are at step three or higher in the federal wage structure. Therefore, when the wages of naval shipyard workers are adjusted as a result of a particular survey, the majority of the workers will receive 4, 8, or 12 percent higher wages than their counterparts in local private industry, depending on the wage step of the individual naval shipyard worker.
- The Navy estimates that the wages of naval shipyard blue-collar workers are about 15 percent higher than wages in private shipyards. This differential is caused by the various provisions of the Federal Wage System.
- There are significant regional differences in shipyard wages. Generally, wages are higher on the West Coast.
- Because of the special facilities and added safety and inspection procedures required to accomplish nuclear work, nuclear shipwork is probably more costly to perform in terms of both direct and overhead costs than comparable non-nuclear shipwork.
- In naval shipyards, disruption of scheduled work and the attendant increased costs are part of the price of providing a rapid-response capability to meet the needs of the fleet.

- Overhead rates among naval shipyards operating under a uniform cost accounting system can vary for a number of important reasons (e.g., management philosophy regarding the proper mix of direct and support workers); therefore, it is not feasible to compare performance among naval shipyards based exclusively or primarily on overhead rates.
- Private shipyards do not employ a universally applied cost accounting system. Within the broad guidance of the Armed Services Procurement Regulation (ASPR), each shipyard is permitted to develop its own cost accounting system consistent with accepted accounting principles; therefore, comparing overhead costs or rates among private shipyards or between private and naval shipyards is extremely difficult.

D. POTENTIAL DOD ACTIONS TO IMPROVE THE COST-EFFECTIVENESS OF SHIPYARD OPERATIONS

This study has identified a number of problem areas that could be addressed by DoD to improve the cost-effectiveness of the accomplishment of Navy shipyard workloads.[1] These problem areas can be grouped homogeneously into six general categories:

(1) Placing Ship Depot Maintenance Workloads in Naval and Private Shipyards
(2) Naval Shipyard Operations
(3) Navy-Private Sector Relationships
(4) Shipyard Capabilities and Capacities
(5) Placing Ship New Construction in Naval Shipyards
(6) Shipyard Performance Data.

[1]Many of these problem areas are necessarily already under study in DoD agencies but are treated in the IDA study to provide full coverage of the results of our analyses.

Following is a brief discussion of each problem area. Within each category, subjects are discussed in a topical manner without regard to priority. For each category, reference is made to the more detailed discussion in Chapter VII of Volume 1.

1. Placing Ship Depot Maintenance Workloads in Naval and Private Shipyards (Chapter VII.A)

a. Advance Planning

The Navy has developed a comprehensive advance planning system to cope with the dynamic and complicated problem of scheduling ship depot maintenance. Several changes designed to make the system more responsive to the unique requirements of shipyard operations are currently being tested. It is too early to assess the overall effectiveness of the Navy's efforts, and we have made no judgment of the total system. However, two areas that may provide opportunities to shorten the overall process and reduce the total amount of resources applied warrant highlighting. First, DoD could undertake a comprehensive study to explore ways to advance the contract award date for ships to be overhauled in private shipyards so private contractors would have longer lead times to prepare for the overhaul. In conjunction with such a study, ways to expand the role of the PERA and increase the use of prestocked long lead time items could also be addressed.

b. Use of Interim Drydockings to Increase the Benefits of Split Bidding

The Navy Repair Manual requires that field contracting officers use split bidding whenever feasible. Under these procedures, large work packages (e.g., ship overhauls) are separated into smaller packages so contractors who otherwise might not have the capability to accomplish the entire work package can bid on a part of the total job. This study discusses the advantages and disadvantages of split bidding, but does not

attempt to judge the merits of splitting work packages to increase competition for Navy work. We believe, however, that the use of interim drydockings, scheduled at regular intervals between overhauls, would be an effective way to reduce the time required for drydocking during the overhaul. This procedure would facilitate increased use of split bidding without encountering potential delays because of the amount of time the ship must stay in drydock during the overhaul.

c. Home-Port Policy

A ship's home port, while not of paramount importance, is a major consideration in developing ship depot maintenance schedules. Navy policy requires that Navy ships be overhauled and repaired in or as close as possible to their operating home ports. This policy helps maintain high morale for personnel and results in improved efficiency through retention of experienced personnel and lower training costs. Offsetting these advantages are potentially higher costs for some Navy shipwork because workloads are concentrated in home-port areas.

The home-port policy will continue to be a very strong influence in helping to maintain ship crew morale. We believe, however, that further research could lead to the identification of alternatives that would permit retention of the home-port policy while alleviating the current concentration of Navy workloads in home-port areas. For example, adoption of policies to promote placement of ship new construction outside of home-port areas and revised basing policies could provide opportunities to redistribute ship workloads and benefit the Navy.

d. Fixed-Price Policy for Ship Depot Maintenance

Naval shipyards operate essentially on a cost-reimbursable basis until 50 percent of the scheduled work on a particular ship is completed. Then the shipyard is required to make a

fixed-price offer to the customer. This policy appears to be an effective way to provide flexibility in dealing with a situation that involves a high degree of uncertainty. This approach recognizes this uncertainty in determining the specific work required during ship depot maintenance and, at the expense of some loss of control by the customer, provides flexibility during the first half of the overhaul. This flexibility is beneficial to both parties since it reduces the time needed to identify and process change orders.

Current contracting procedures do not permit the Navy to work with private shipyards on this basis, although the same uncertainty exists with regard to the amount and cost of required work. The approach used in dealing with private shipyards emphasizes control by the customer throughout the overhaul at the expense of lost flexibility and increased time to identify and process change orders. We were unable to examine the full implications of these contrasting approaches to dealing with a situation that involves a high degree of uncertainty. A detailed analysis of current fixed-pricing procedures in contracting with both naval and private shipyards, however, could determine the benefit/cost relationships between the two contrasting systems and might identify ways to facilitate the handling of work placed in both sectors.

e. <u>The 70/30 Allocation of Navy Ship Depot Maintenance Between Naval and Private Shipyards</u>

Although the Navy opposes rigid limitations on the division of work between naval and private shipyards, it has elected to pursue a policy of a 70/30 split based on the general *guidance* of DODD 4151.1. This policy is pursued despite the fact that naval shipyards are currently operating inefficiently in terms of potential employment levels and available equipment and facilities. It is reasonable to expect the cost-effectiveness

of naval shipyard operations to improve if the current excess capacity is used to accomplish additional ship workloads.

An examination of alternative allocations of Navy ship depot maintenance workloads in both naval and private shipyards could be of benefit to the Defense Department. Such a study could consider projected peacetime and war-mobilization requirements and determine the most cost-effective alternative for accomplishing Navy ship workloads. That alternative should then be adopted for placing Navy ship workloads in both naval and private shipyards regardless of the final distribution of work between the two sectors.

f. <u>The Master Ship Repair Contract (MSRC) System as a Management Tool</u>

To be eligible to perform work on naval ships, a private contractor must hold a MSRC, which establishes in advance the terms under which he will perform Navy shipwork. We believe this system could be better exploited as a tool to help the Navy improve its knowledge of the capability and capacity of the private shipyards that respond to Navy work requests. The Navy, for example, could develop a management information system, based on the current MSRC system, that would establish specific criteria to be met before a private shipyard can be determined to be qualified to perform prescribed shipwork categories. Separate criteria in terms of facilities, equipment, manpower levels, trade skills and mixes, support services, and the like could be established for standard work categories. These data would serve a dual purpose. First, the Navy would be better able to eliminate marginal contractors in placing workloads. Second, individual private shipyards would have a valid basis upon which to make decisions about improving their capability and capacity to respond to projected Navy workloads.

2. Naval Shipyard Operations (Chapter VII.B)

a. The Naval Industrial Fund (NIF) Concept

In addition to providing an effective means of financing, budgeting, and accounting for the costs of operating industrial activities, the NIF is designed to be a management system. It is intended to create producer-customer relationships comparable to those achieved by efficient private enterprises in similar types of activities. These relationships are designed to provide managers and customers incentives for efficiency and economy. There are indications, however, that the NIF has become essentially an accounting system and is used only to a limited extent as a management system. In fact, many congressional, DoD, Civil Service Commission, and Navy policies under which shipyards are operated (e.g., manpower ceilings, restrictions in hiring and firing, use of temporary employees) limit rather than encourage maximum cost-effectiveness in an industrial environment. If these operating constraints cannot be removed or alleviated, less complex and expensive procedures should be considered to achieve the desired producer-customer relationships intended by the industrial fund.

b. Funding Overhauls on an Annual Basis

A major portion of ship overhauls is financed by funds that are appropriated on an annual basis. These funds *must* be obligated in the same year for which they are appropriated. One-year funding for work that must be planned and scheduled considerably in advance of the ship's arrival in the yard is not sufficient to assure stable workloads and does not provide adequate incentives for private shipyards to make capital investments in long-range projects.

Problems associated with one-year funding are not unique to ship overhauls. The congressional policy of one-year funding

also creates difficulties in the planning and scheduling of depot maintenance on aircraft and other major weapon systems; however, ship overhauls are normally of relatively longer duration than other types of depot maintenance. Ship overhauls on major combatant vessels sometimes require 12 to 15 months to complete. Establishing a Ship Overhaul Appropriation with multi-year obligation authority, similar to that authorized in the procurement and research and development appropriations, would facilitate planning and scheduling of overhauls. Authorizing obligation of funds on this basis could encourage private shipyards to make capital investments leading to greater efficiency and relatively lower prices for overhauls.

c. Manpower Considerations in the Shipbuilding and Repair Industry

We have evaluated some of the factors related to manpower that impact both private and naval shipyards. We believe that to assure a vigorous shipbuilding and repair industry, improved planning at the federal level is required to determine the benefit/cost relationships of policies that affect the quality and quantity of available labor. For example, a joint DoD-MARAD-Labor Department analysis of manpower-related factors (e.g., expanded training programs; shipyard turnover rates, including the implications of an apparently "itinerant" component of the private shipyard work force; and impact of relative wage adjustments) could lead to improvements in the overall effectiveness of shipyard operations.

d. Naval Shipyard Utilization

In addition to their role in accomplishing scheduled depot maintenance, naval shipyards provide an immediately available mobilization base and a rapid-response capability for accomplishing unscheduled, often emergency, ship repair. This situation,

combined with current manpower ceilings, the policy of allocating 30 percent of depot maintenance to the private sector, and constraints on funding, causes naval shipyards to operate inefficiently. This excess capacity, in turn, causes the costs incurred by naval shipyards to be higher than they otherwise would be. Permitting naval shipyards to employ additional personnel and to increase the total workload to eliminate excess capacity would make their operations more cost-effective.

e. Evaluating Naval Shipyard Performance

Generally accepted overall performance measures do not exist for industrial repair and overhaul activities, such as shipyards. Consequently, conclusions about relative shipyard performance derived from the limited, routinely published data can be misleading unless carefully evaluated. In this study, we have developed a set of performance measurement concepts that could be used by the Navy in monitoring naval shipyard operations. These performance measurement concepts include development and publication of performance indicators to monitor efficiency trends, data about the extent to which ships are completed on time and at negotiated cost, and an expanded work standards program.

f. The Federal Wage System

The Federal Wage System, which prescribes the procedures to be followed in making annual adjustments to federal blue-collar wages, causes wages in naval shipyards to be significantly higher than wages for workers in comparable jobs in local private industry. These higher wages are the major reason why costs incurred by naval shipyards in performing shipwork are generally higher than the costs of comparable work in the private sector. Achieving comparability between federal and private sector wages, however, is not a problem unique to the shipyard industry since the provisions of the Federal Wage System apply to all

federal wage workers. Naval versus private shipyard wage differentials could be rectified by changing the Federal Wage System, but this is an industry-wide rather than just a shipyard problem.

3. Navy-Private Sector Relationships (Chapter VII.C)

a. Use of Negotiated Contracts to Direct Complex Jobs to the Best Qualified and Proven Private Shipyards

Current federal procurement procedures stress the use of advertised procurement. Under this form of procurement, contracts are generally awarded to the lowest bidders, since the burden is on the government to prove that bids are nonresponsive. This form of procurement, however, may not be the best way to award contracts for the overhaul of complex vessels because the lowest bidder may not be the one best qualified to do the work. Use of negotiated procurement procedures could help to ensure that complex shipwork is placed in the best qualified private shipyards. In addition, the Navy should consider using the multi-ship package approach to ship overhauls whenever that approach would provide the opportunity of assuring that ship workloads are placed with the most cost-effective private shipyard. Under this approach, the Navy would enter into a contract for a series of overhauls with a single contractor, thus permitting the contractor to plan his operations on a longer range basis.

b. Lack of Use of Discretionary Authority by Local Naval Officials

Navy personnel assigned to SUPSHIP offices are responsible for administering contracts for work placed in private shipyards. Despite the fact that many of these personnel are involved in making contract changes, their authority to make timely decisions is limited. Because of the large volume of change orders and the requirement for the Navy to inspect and approve a large part of the work before the private shipyard

can proceed, this situation has sometimes resulted in undue delays. Some SUPSHIP offices employ one individual, a generalist, known as a surveyor, to perform the functions of planner, estimator, and inspector. Use of surveyors not only reduces the number of people who must deal with the contractor but also provides the opportunity to increase SUPSHIP effectiveness. The overall effectiveness with which the Navy manages its work assigned to private shipyards could be increased by (1) expanding the use of surveyors in routine operations; (2) granting increased authority to surveyors; and (3) upgrading the criteria for appointment as a surveyor to require broader, more extensive experience in all aspects of administering contracts for work placed in private shipyards.

4. Shipyard Capabilities and Capacities (Chapter VII.D)

a. Number of Shipyards Certified to Work on Nuclear Ships

Currently, all nuclear ship overhaul and repair work is accomplished in the six naval and three private shipyards that are licensed to perform nuclear work. The required data were not made available by the Navy to permit us to evaluate the cost-effectiveness implications of the number of shipyards certified to perform nuclear work versus actual and projected nuclear workloads. Nevertheless, we believe that the question of establishing and maintaining the proper balance between the number of naval and private shipyards capable of working on nuclear ships and the actual and projected nuclear workloads is of vital importance and must be reexamined. This requirement is especially critical in view of the projected increase in the number of nuclear ships.

b. The Naval Shipyard Modernization Program

The Naval Shipyard Modernization Program has been in existence for 10 years, but only about one-third of the

facilities objectives and about one-half of the equipment objectives have been achieved. Because modern naval shipyard equipment and facilities are essential to cost-effective performance of ship depot maintenance, especially in terms of the high cost of labor, the DoD should approve funds to accomplish the objectives of the program.

c. Providing Incentives for Private Shipyards to Increase Their Capability and Capacity to Accept Navy Shipwork

According to NAVSEA estimates, only a few private shipyards currently can accomplish the complex overhauls of major combatant ships. Consequently, overhauls for these ships are generally accomplished in naval shipyards. Recent developments, including the projected increase in the number of combatant ships, the growth in overhaul work packages, and drydock limitations, indicate that more of these complex overhauls may have to be assigned to private shipyards. One course of action available to the Navy to increase the number of private shipyards capable of performing this work is to provide incentives for the private ship repair industry to expand its capability and capacity. A primary deterrent to expansion in the private sector is the high degree of uncertainty in the volume and types of workloads projected to be assigned to the private sector; thus, any management action that will reduce this uncertainty may provide an incentive for the industry to consider expansion. To reduce such uncertainty, the Navy could (1) distribute to all private shipyards on the MSRC list a three-year schedule of ships projected for assignment to the private sector for depot maintenance, (2) use more negotiated job orders under MSRC procedures, (3) use more multi-ship work packages, and (4) revise work package development procedures to permit splitting work between private and naval shipyards. Other ways to provide incentives for private shipyards to improve their capabilities to handle Navy depot maintenance

work might include leasing more government facilities and equipment to private contractors, use of more "captive" shipyards, and provision of long-range financial incentives.

5. Placing New Construction in Naval Shipyards (Chapter VII.E)

In assessing various possibilities for improving the cost-effectiveness of shipyard work, we have examined the question of whether the DoD should resume a policy of having some Navy ship new construction accomplished in naval shipyards. The environment in the shipbuilding and repair industry has changed significantly since the Navy decision in 1966 to stop building ships in naval shipyards, and reconsideration of that decision may be appropriate. Moreover, if other actions recommended in this paper are taken, those actions could have an important influence on the variables that should be considered in such a study. For these reasons, we believe the DoD should initiate a new study to determine if Navy ship new construction should be resumed in naval shipyards.

6. Shipyard Performance Data (Chapter VII.F)

a. Routine Publication of Shipyard Statistics

The Navy currently publishes *The Statistics of Naval Shipyards (SONS)* as a comprehensive data base for the discussion and monitoring of naval shipyard performance. Except for the limited information about individual ship availabilities, this document is an excellent source of summary-level data about naval shipyards. No comparable source of information about the performance of private shipyards in accomplishing Navy workloads could be identified during this study.

Several potential actions are available to DoD to expand the amount of performance information that is routinely published for private and naval shipyards. For example, the *SONS* could be expanded to include information that would reflect the

extent to which originally projected cost and schedule milestones are achieved for each ship availability. In addition, NAVSEA could publish a document, similar in concept to the current *SONS*, that would provide comparable statistical information about private shipyards. These actions could be valuable steps in the development of a comprehensive basis for comparing the performance of private and naval shipyards.

b. Improved Cost Data Detail on Private Shipyards

A major problem in comparing the relative performance of naval and private shipyards is the lack of readily available detailed data about the mandays expended and costs incurred by private shipyards in accomplishing Navy ship workloads. Improved data, which could be used by the Navy both to evaluate current performance and to develop standards for future performance, would provide a basis for improving the overall cost-effectiveness of shipyard operations. These data are required especially for complex overhauls and major conversions that require thousands of mandays and millions of dollars to complete.

The provisions of DODI 7000.11, "Contractor Cost Data Reporting," 5 September 1973, currently used by DoD to obtain detailed data from private contractors for major acquisition programs would provide a reasonable approach to increasing the amount of data available from private contractors for complex ship overhauls.

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PREFACE

This paper, prepared by the Cost Analysis Group of the Institute for Defense Analyses, reports on work accomplished for the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation (PA&E) under Task Order PA&E-81, dated 5 August 1974.

As directed in the task order, comparative analyses were performed of cost and institutional factors relating to performance of Navy ship workloads in commercial and naval shipyards. The major emphasis of the research was on ship depot maintenance; however, factors relating to ship new construction were also considered. This study was designed to aid the Office of the Assistant Secretary of Defense (PA&E) in the development of program and fiscal guidance for Navy ship depot maintenance.

Volume I comprises the basic report. Chapter I discusses the background of the study and outlines the study approach. This chapter also contains institutional material on the U.S. shipbuilding and repair industry and on financing of Navy shipyard work.

Chapter II contains a documentation and analysis of the differences in facilities, organizations, and manpower skills required for ship depot maintenance versus new construction in typical naval and commercial shipyards. Chapter III discusses DoD policies and Navy procedures for placing ship depot maintenance work, both scheduled and unscheduled (emergent), in naval and private shipyards.

In Chapter IV, various methods of measuring the performance of shipyards are discussed and evaluated. This chapter includes definitions of productive ratios and an assessment of their validity as measures of productivity. Documentation and

analysis of the factors that influence the cost of accomplishing Navy ship depot maintenance follow (in Chapter V), with emphasis on shipyard overhead rates and the major factors that influence those rates. The discussion in Chapter V focuses on naval shipyards because of limited accessibility to cost data from private shipyards.

Early in the study, the study team concluded that considerable uncertainty exists regarding the availability of skilled manpower to perform forecasted future naval and commercial shipyard workloads. Therefore, special research was performed to attempt to determine the status of the shipyard skilled labor market. Chapter VI presents the results of that research.

Finally, Chapter VII contains summary evaluations and analyses of major subjects covered in the study. Also included are recommendations on policy and procedural changes and areas for further study to improve the cost effectiveness of the performance of shipyard work.

Volume II contains appendixes that support and amplify material presented in the basic report. Volume III is an annotated bibliography containing abstracts of 150 documents that relate to the subject area of the study.

Members of the IDA study team extend their appreciation to the many professional people in the Navy (military and civilian), the Maritime Administration, other government agencies, and the commercial shipbuilding and repair industry who, through their cooperation and assistance, enabled us to conduct this study.

Periodic reviews and critiques of our work were performed by a Technical Review Board (TRB) composed of Rear Admiral C.R. Bryan, USN, Director of the Ship Material Readiness Division, Office, Deputy Chief of Naval Operations (Logistics); Mr. Herman M. Bading, Office, Assistant Secretary of Defense (Installations and Logistics); and Dr. Charles L. Trozzo of Richard J. Barber Associates. We appreciate the constructive comments and recommendations of the Technical Review Board.

LIST OF ABBREVIATIONS

ADP	Automated Data Processing
ADS	Automated Data System
AE	Ammunition Ship
ALT	Alteration
ASN(I&L)	Assistant Secretary of the Navy for Installations and Logistics
ASPR	Armed Services Procurement Regulation
ASW	Anti-submarine Warfare
BACD	Basic Alteration Class Drawing
BLS	Bureau of Labor Statistics
CAG	Cost Analysis Group
CAR	Conversion, Alteration and Repair
CASB	Cost Accounting Standards Board
CASDO	Computer Application Support and Development Office
CASREP	Casualty Report
CDS	Construction Differential Subsidy
CETA	Comprehensive Fmployment and Training Act
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
COSAL	Coordinated Shipboard Allowance List
CSC	Civil Service Commission
CSMP	Current Ship's Maintenance Project
CVA	Attack Aircraft Carrier
CVAN	Attack Aircraft Carrier, Nuclear Powered
DD	Destroyer
DDG	Guided Missile Destroyer
DE	Escort Destroyer

D&F	Determination and Findings
DL	Direct Labor
DLG	Guided Missile Frigate
DLGN	Guided Missile Frigate, Nuclear Powered
D-M	Depot Maintenance
DMDE	Direct Mandays Expended
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DWG	Drawing
EAM	Electric Accounting Machine
FCO	Field Contracting Officer
FMAG	Fleet Maintenance Assistance Group
FMP	Fleet Modernization Program
F&O	Financial and Operating Statement
FOA	Fitting Out Availability
FPM	Federal Personnel Manual
FWE	Functional Work Element
FWG	Functional Work Group
FWI	Functional Work Item
FWRS	Federal Wage Rate Schedule
FWS	Federal Wage System
FY	Fiscal Year
FYDP	Five Year Defense Program
GFM	Government Furnished Material
GOCO	Government Owned Contractor Operated
GPO	Government Printing Office
GS	General Schedule (Employees)
HMR	Headquarters Modification Request
ICP	Inventory Control Point
IDA	Institute for Defense Analyses
IF	Industrial Fund
IFB	Invitation for Bid
INSURV	Board of Inspection and Survey

LANTFLT	Atlantic Fleet
LLTM	Long Lead Time Material
LOA	Length-Over-All
LOR	Level of Repair
LRPS	Long-Range Planning System
LSD	Landing Ship Dock
MAP	Military Assistance Program
MARAD	Maritime Administration
MCON	Military Construction Appropriation
MDTA	Manpower Development and Training Act of 1962, as Amended
MIS	Management Information System
MPA	Military Personnel Appropriation
MSC	Military Sealift Command
MSRC	Master Ship Repair Contract
NAB	National Association of Businessmen
NAVELEX	Naval Electronic Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVORD	Naval Ordnance Systems Command
NAVSEA	Naval Sea Systems Command (formed by combining NAVSHIP and NAVORD)
NAVSHIP	Naval Ship Systems Command
NAVSUP	Naval Supply Systems Command
NC	New Construction
NIF	Navy Industrial Fund
NNSY	Norfolk Naval Shipyard
NPD	Navy Procurement Directive
OASD(C)	Office of Assistant Secretary of Defense (Comptroller)
OASD(I&L)	Office of Assistant Secretary of Defense for Installations and Logistics
OASD(PA&E)	Office of the Assistant Secretary of Defense for Program Analysis and Evaluation
OECD	Organisation for Economic Co-operation and Development

O&I	Organizational and Intermediate
OMB	Office of Management and Budget
O&MN	Operations and Maintenance, Navy Appropriation
OP-43	Ship's Material Readiness Division
OP-90	General Planning and Programming Division
OP-92	Fiscal Management Division
OP-96	Systems Analysis Division
OPN	Other Procurement, Navy Appropriation
OPNAV	Operations, Navy
OSD	Office of Secretary of Defense
PACFLT	Pacific Fleet
PERA	Planning and Engineering for Repairs and Alterations
POM	Program Objectives Memorandum
POT&I	Preoverhaul Test and Inspection
PPBS	Planning Programming and Budgeting System
PWER	Planned Workload Employment Report
PWF	Productive Workload Forecast
QA	Quality Assurance
RADCON	Radiological Control
RAV	Restricted Availability
RDT&E	Research Development Test and Evaluation
RFP	Request for Proposal
ROH	Regular Overhaul
S/A	Ship Alteration
SAR	Ship Alteration Record
SARP	Ship Alteration and Repair Package
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SCN	Shipbuilding and Conversion, Navy Appropriation
SF	Standard Form
SFOMS	Ship's Force Overhaul Management System
SIC	Standard Industrial Classification
SLM	Ship Logistic Manager

SONS	Statistics of Naval Shipyards
SPCC	Ship Parts Control Center
SRCM	Ship Repair Contracting Manual
SRD	Selected Record Data/Drawings
SRF	Ship Repair Facility
SSBN	Submarine, Ballistic Missile, Nuclear
SSN	Submarine, Nuclear
SUPSHIP	Supervisor of Shipbuilding, Conversion and Repair
SYSCOM	Systems Command
TAV	Technical Availability
TOR	Turnover Rate
TYCOMS	Type Commanders
WDC	Work Definition Conference
WG	Wage Grade (Employees)--Non-supervisory
WL	Wage Grade (Employees)--Leader
WPN	Weapons Procurement, Navy Appropriation
WS	Wage Grade (Employees)--Supervisory

Chapter I

INTRODUCTION

In fiscal year 1975 the United States Navy budget included about $3.8 billion to procure new ships and $1.8 billion to convert, alter, and repair active and reserve fleet ships in naval and private shipyards. These funds for ship new construction and depot maintenance accounted for 22 percent of the total Navy FY 1975 budget. Table 1 contains a summary of these Navy ship programs from FY 1972 through FY 1976.[1] Data for FY 1972 through FY 1974 show actual expenditures; for FY 1975 and FY 1976 the data are based on the applicable fiscal year budget.

Since FY 1966 the Navy has contracted with private industry for the construction of all new ships. Private industry also performs roughly 30 percent of the Navy's ship conversion, alteration, and repair work (referred to as depot maintenance in the Department of Defense, and repair in private industry).[2] The eight naval shipyards are engaged exclusively

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[1]Data are in current year dollars and were not normalized to remove effects of inflation during the period.

[2]DoD Directive 4151.16, Equipment and Maintenance Program, August 30, 1972, sets forth objectives and policies for equipment maintenance management and engineering programs in DoD. This directive identifies depot maintenance as requiring more extensive shop facilities and equipment and personnel of higher technical skill than are available at the lower organizational and intermediate levels of maintenance. It states ". . .depot maintenance is normally accomplished in fixed shops, shipyards and other shore based facilities or by depot field teams." Repair, modification, alterations, modernization, conversion, and overhaul, as well as many other tasks are identified as depot maintenance functions. In Department of Commerce and other federal government publications (continued on next page)

Table 1. NAVY SHIP NEW CONSTRUCTION AND DEPOT MAINTENANCE PROGRAMS, FY 1972-1976

(In millions of dollars)

Programs	1972	1973	1974	1975	1976
1. Ship New Construction	1,998	1,505	3,588	3,810	5,499
2. Ship Conversion, Alteration, and Repair	1,422	1,670	1,753	1,808	1,974
3. Total Ship Programs	3,420	3,175	5,341	5,618	7,473
4. Total All Navy Programs	22,034	23,123	24,477	25,623	30,981
5. Line 3 ÷ Line 4	16%	14%	22%	22%	24%

Sources: Lines 1 and 2 supplied by U.S. Naval Sea Systems Command, Civilian Manpower/NIF/Modified NIF Budget Division, April 1975. Line 4 supplied by OASD/PA&E, Cost and Economic Analyses Directorate, July 1975.

in depot maintenance although four of the yards currently have some capability to build new ships, if required.

In terms of total business, the value of work done in United States private shipyards in calendar year 1974 was $1,840 million for the U.S. Navy and $2,200 million for commercial customers. In FY 1975 the naval shipyards produced goods and services valued at $1,155 million. Clearly, shipbuilding and repair in the aggregate is an important industry.

The United States has always placed a high priority on the need for a strong Navy and Merchant Marine. Strong fleets of ships are dependent upon healthy, viable shipbuilding and repair industries; therefore, this industry has been the

(cont'd) the industry that performs ship new construction and ship depot maintenance, as just described, is referred to as the shipbuilding and repair industry; therefore, the terms repair and depot maintenance will be used interchangeably in this paper. When reference is made to private industry the term repair will normally be used rather than depot maintenance.

subject of unusual attention quite disproportionate to its size in relation to other industries.

The United States has experienced special problems in maintaining a shipbuilding and repair industry considered adequate to meet the country's existing and potential requirements. Many Navy shipbuilding and repair programs have exhibited the "feast or famine" characteristics that often plague military programs. Shipbuilding and repair support for commercial requirements has suffered from the high cost of labor in the U.S., as compared with other countries, and the inability of the industry to offset these higher costs with greater productivity.

In recent years several developments have caused increased attention to be focused on the U.S. shipbuilding and repair industry. Some of the major developments were:

(1) A reduction in the size of the U.S. Navy with the total number of ships declining from 976 in 1968 to 497 on 30 June 1975.

(2) A steady decline in the size of the U.S. Merchant Marine with ever-increasing percentages of United States cargoes being carried by foreign-registered ships.[1]

(3) The construction of limited numbers of commercial ships in United States shipyards, prior to 1970.

(4) The passage of the Merchant Marine Act of 1970, making the U.S. maritime industry more competitive.[2]

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[1]From 1962 to 1972 the U.S. Flag percentage share of U.S. seaborne foreign trade tonnage declined from 10% to 5.5%. Actual tonnage in U.S. Flag ships declined from 29.6 to 24.6 millions of long tons. See *Report of the Commission on American Shipbuilding, II,* Washington, D.C., October 1973, p. 184. The United States Merchant Marine active fleet declined from 915 vessels in 1964 to 590 in 1974. Gross tonnage (cubic measure of volume) declined slightly from 9,492 to 9,343 thousands of gross tons. See U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974,* 91st Cong., 2nd sess., July-October 1974, Part 2, p. 626.

[2]Significant features of the Merchant Marine Act of 1970 are: the establishment of a program to rebuild with Federal assistance the merchant fleet by equipping the fleet with ships of advanced design; emphasis placed on the development of ships of standardized design and (continued on next page)

In addition to these major developments, other events have occurred that are more limited in scope but affect the shipbuilding and repair industry and relationships between the private sector of that industry and the United States Navy. Among these developments were:

(1) Changes, since 1960, in Navy procurement policies relating both to ship new construction and repair.

(2) Changes in ownership and control of shipyards in the private sector of the industry.

(3) The DoD decision in 1966 to place all new ship construction in private shipyards.[1]

(4) The severe inflation in the United States since 1969.

(5) The increase in Naval ship size (dimensions and displacement) and complexity with resulting higher procurement and repair costs.

As a result of these developments many federal government agencies have undertaken studies of the United States shipbuilding and repair industry. This paper covers an Institute for Defense Analyses (IDA) study designed to aid the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation (OASD/PA&E) in developing program and fiscal guidance for United States Navy shipyard work.

A. THE INSTITUTE FOR DEFENSE ANALYSES (IDA) TASK

In August 1974, OASD/PA&E asked IDA to undertake a study "To perform comprehensive comparative analyses of costs and institutional factors relating to performance of Navy ship

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(cont'd) the introduction of series production techniques to lower unit costs; a scale of construction-differential subsidies (CDS) established with the subsidies paid directly to the ship builders rather than to the ship owners; new contracting techniques encouraged—negotiated contracts, formerly prohibited, now permitted; multi-year procurements utilized with the government's share of the cost financed over the longer construction period instead of being appropriated in a single year; and for the first time all types of bulk carriers eligible for operating and construction subsidies.

[1]Shipyards in the private sector will be referred to as either private or commercial shipyards in this paper.

workloads in commercial and naval shipyards." This study was to provide the following outputs:

(1) A documentation and analysis of the differences in facilities, organizations, manpower skills, and other industrial factors required for ship construction versus depot maintenance in typical naval and commercial shipyards.

(2) A description of the Navy procedures for placing ship depot maintenance work in naval and commercial shipyards, and an evaluation of the effects of these procedures on implementation of Navy ship depot maintenance programs.

(3) Definitions of productive ratios and assessments of their validity as measures of shipyard productivity.

(4) Documentation and analysis of overhead rates to identify the major factors influencing them.

(5) Analyses of shipyard industrial factors to evaluate the effects of these factors on shipyard costs and capabilities to respond to varying workload magnitude and mix.

(6) Identification of possible actions available to DoD to improve the cost-effectiveness of shipyard work performance.

Although the study was to consider some factors related to ship new construction, the major emphasis was on ship depot maintenance.

B. THE CONDUCT OF THE STUDY

1. Guidelines

The IDA study team adopted the following guidelines at the outset of the research:

(1) The study must view the U.S. shipbuilding and repair industry, naval and private, as a total system designed to fulfill, in the aggregate, U.S. Navy and commercial fleet requirements.

(2) The U.S. Navy is a national public interest institution. This may require the Navy to operate under different management concepts and implement different administrative and contractual procedures from those employed in the private sector.

(3) It cannot be assumed in advance that Navy workload distribution between naval and commercial shipyards must be based on arbitrary percentage criteria unrelated to maximum efficiency and effectiveness. The study is directed toward identifying, in the public interest, optimum ways to perform U.S. Navy workloads. All existing policies and procedures are candidates for analysis and recommendations for change to achieve this optimum system.

(4) Research will be limited to naval and commercial shipbuilding and repair activities in the United States. Some ship repair operations are performed overseas in U.S. facilities possessing characteristics of naval shipyards, but these facilities will not be included in the study. Furthermore, the study will not examine repair activities at the organizational or intermediate levels of the Navy fleets.

(5) The study will not assess the appropriateness of Navy-defined ship overhaul cycles. The study will accept, as valid, Navy-computed annual ship depot maintenance and associated financial requirements. The so-called "bow wave" will be accepted as an indicator of deferred maintenance on Navy ships.

(6) Productivity will be examined in terms of outputs versus resource inputs in industrial facilities. No attempt will be made to study questions related to the productivity of individuals within the shop environment.

2. Research Actions

The IDA study team conducted its research as follows:

(1) A thorough review was made of existing publications in the area covered by the study. A comprehensive annotated bibliography was then prepared for possible use by future researchers.

(2) Visits were made to five of the eight naval shipyards and to six commercial shipyards. The team also visited six Navy Supervisors of Shipbuilding, Conversion and Repair (SUPSHIP).[1] In these visits extensive discussions were held with management and staff personnel at all levels; reports and data were reviewed; and walking tours were conducted throughout the yards.

[1]These offices are responsible for administration of Navy contracts with private shipyards. SUPSHIP activities will be discussed in greater detail in Chapters II and III.

(3) A questionnaire was forwarded to 95 private shipyards to secure information of importance to the study. Replies were received from 41 companies and the information was incorporated into the study without identification of individual companies.

(4) Policy and procedural materials and extensive data were secured from Department of Defense agencies, the Maritime Administration, the Bureau of Labor Statistics, the Cost Accounting Standards Board, and Departments of Labor in several states.

(5) Early in the study it was determined that availability of skilled manpower is critical in the shipbuilding and repair industry. Therefore, special research was undertaken to identify the current shipyard manpower situation and to assess possible future manpower developments in the industry.

(6) Analyses were conducted and the products (listed in Section A above) were prepared.

C. THE INSTITUTIONAL FRAMEWORK OF THE UNITED STATES SHIPBUILDING AND REPAIR INDUSTRY

1. Naval Shipyards

Shipyards in the United States are of two types--naval and private. The U.S. Navy has eight organic naval shipyards; these yards perform work on U.S. Navy vessels, plus a limited amount of work for other customers such as the other United States military services and countries receiving military assistance support. As mentioned earlier, the shipwork performed in these naval shipyards is entirely depot maintenance.

Most of the work in naval shipyards is for ship repair and overhaul, but approximately 10 percent of the manhours expended is for non-shipwork such as manufacture of steel fabricated equipment; research and development; improvement of plant property; and support of various military facilities in the shipyard complex.

All of the naval shipyards are long established industrial facilities except the Long Beach, California, yard, established immediately prior to World War II. Table 2 lists the naval shipyards and their employment levels as of June 30,

Table 2. NAVAL SHIPYARD INDUSTRIAL CHARACTERISTICS

Shipyard	Year Authorized By The Congress	Employment Level (30 June 1974)	Land Area (Acres)	Acquisition Cost Of Capital Equipment And Facilities (In thousands of dollars)
Portsmouth	1799	5,688	248	88,687
Philadelphia	1799	6,760	818	207,618
Norfolk	1799	10,153	791	211,767
Charleston	1901	6,696	2,002	132,877
Long Beach	1940	7,469	246	93,346
Mare Island	1852	8,301	3,454	197,194
Puget Sound	1891	9,990	1,088	185,982
Pearl Harbor	1908	4,927	5,131	118,997
Total		59,984	13,778	1,236,468

Sources: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 91st Cong., 2nd sess. July-October 1974, Part 1. U.S. Naval Sea Systems Command, *Statistics of Naval Shipyards*, June 1974, Table 3; and NAVSEA, Directorate of Field Activities.

1974, as well as the year the yard was authorized by the Congress, the size of each yard in terms of acreage, and the acquisition costs of capital equipment and facilities. Although some equipment and facilities are not modern, the naval shipyards possess comprehensive industrial capabilities and capacities.

About 60,000 Navy employees work in these eight naval shipyards. Employment levels vary from about 6,000 at the Portsmouth yard to over 10,000 at Norfolk and Puget Sound. Roughly 75 percent of the employees in all yards are blue collar workers.

All naval shipyards are commanded by a United States Navy officer. When this study was conducted, the commanders of five yards were Navy Captains; the Norfolk, Charleston and Puget Sound Naval Shipyards were commanded by Rear Admirals. Most senior staff positions are filled by U.S. Navy officers. Virtually all line positions below the level of top shipyard management are filled by federal civil service employees. A typical naval shipyard is staffed 99 percent by civilians; e.g., the Charleston Naval Shipyard had 65 military personnel and 6,457 civilians on 31 March 1974.

Naval shipyards operate under the Navy Industrial Fund (NIF) system. Industrial funds are revolving funds used to finance the operations of designated industrial-commercial type activities. The industrial fund system creates a producer-customer relationship similar to the buyer-seller relationships in the private business sector. It is assumed that such relationships create incentives for greater efficiency and economy by both producer and customer in DoD. This system is explained in greater depth in Appendix N.

Under the Navy financial management system virtually all customer funds required to finance ship depot maintenance are allocated to the type commanders in the Atlantic and Pacific Fleets who have cognizance over assigned vessels of given types and classes. The type commanders negotiate prices, quantities,

and other contractual elements with the industrially funded naval shipyards for ship depot maintenance work to be performed on their vessels in the shipyards.

The NIF employs a comprehensive job order cost accounting system which permits the naval shipyards to accumulate cost data for workload cost estimating and to track expenses incurred versus budgets as work proceeds.

In principle, the naval shipyards operate on a break-even basis through the fiscal year. They expend resources of labor, materials, and overhead to produce depot maintenance services. They recover their expenses by billing the designated shipyard customers. Total expenses should equal total revenues over the fiscal year period.[1]

The eight naval shipyards are assigned to the Naval Sea Systems Command. All are administered through a highly standardized system, including uniform NIF accounting procedures and personnel policies established by the DoD and the Federal Civil Service Commission.

2. Private Shipyards

In contrast to the naval shipyard segment of the United States shipbuilding and repair industry, the private sector is characterized by great diversity. This applies not only to size and facilities, but also to organization, ownership, financing, management, and administration.

A Department of Commerce publication lists 257 private shipbuilding and repair activities located within the United States.[2] Of the 202 activities that provided information for

[1]This excludes costs for military personnel and capital improvements. These resources are provided to the shipyards directly by the Navy without recovery of costs through the NIF system.

[2]U.S. Department of Commerce, Maritime Administration (MARAD), Office of Ship Construction, *1973 Report on Survey of U.S. Shipbuilding and Repair Industry*, Washington, D.C., 1974.

a 1973 survey, maximum potential employment levels of individual activities ranged from 12 to 41,000 employees.[1] These shipyards vary from small boat shops to repair yards with or without drydock facilities, to complete shipyards comparable to naval shipyards, to highly specialized shipbuilding facilities larger than any of the eight naval shipyards. Figure 7 in Chapter II presents a percentage distribution of the 202 private shipyards by maximum potential employment levels. In the private shipyard sector, considering facilities and other industrial constraints, 56 percent of the yards have the potential to employ less than 500 employees. Only 12 percent have the facilities to accommodate over 5,000 employees.

Of special interest to the Navy is the group of private shipyards that are eligible to perform Navy ship depot maintenance and new construction. Currently, 188 private shipyards are included on the Navy's Master Ship Repair List (MSRL). A private shipyard must sign a Master Ship Repair Contract (MSRC) and be placed on the Navy's MSRL to be eligible to bid on Navy ship depot maintenance work.[2] These 188 shipyards requested placement on this list, and the Navy has determined that they are qualified to perform some level of ship depot maintenance. Table 3, Part A shows the categories of private shipyards that have signed Navy MSRCs and are available to perform Navy ship depot maintenance. Only 21 of these private shipyards have the facilities required to perform an overhaul of a complex

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[1]Maximum employment potential as used by the Navy is equivalent to mobilization employment potential as used by the Maritime Administration--an estimate of the employment utilization potential under multi-shift full mobilization conditions.

[2]Master Contract for Repair and Alteration of Vessels, DD ASPR Form 731, as prescribed by Armed Services Procurement Regulation 16-503.1, establishes in advance the terms upon which a contractor will effect repairs, completions, alterations of and additions to vessels and parts thereof under the provisions of job orders issued by government contracting activities.

Table 3. CATEGORIES OF PRIVATE SHIPYARDS POTENTIALLY AVAILABLE TO PERFORM NAVY WORKLOADS

Categories	Number
A. Depot Maintenance Capable Shipyards	
Types of Facilities	
1. Holders of Master Ship Repair Contracts	188
2. Shipyards With Facilities to Perform Complete Overhauls on Major Navy Ships	24
3. Shipyards With Facilities for Complex Combatant Navy Ships	21
4. Shipyards Licensed and Qualified for Nuclear Ship Repair and Overhaul	3
B. New Construction Capable Shipyards	
Maximum Potential Employment Level	
1. 10,000 or more	9
2. 5,000 to 9,999	6
3. Less than 5,000	6
4. Employment Potential Not Available	4
Total	25

Sources: Section A: U.S. Naval Sea Systems Command Industrial Activity Work and Resources Planning Division. Section B: Department of Defense and Department of Commerce, Office of the Coordinator for Ship Repair and Conversion, *1973 Report on Survey of U.S. Shipbuilding and Repair Industry*, Washington, D.C., 1974.

combatant Navy ship. As of the time of this study only 7 of these 21 had sufficient employees with the proper mix of specialized skills to perform these overhauls, although all 21 yards had adequate facilities. These 7 yards employ about 73,000 of the roughly 157,000 employees working in private shipyards as of March 1975.

Ship repair costs are an indicator of the amount of resources a firm must possess to perform depot maintenance on major Navy ships. Overhauling a nuclear attack submarine costs about $21 million and normally takes twelve months. For a large aircraft carrier, the cost totals roughly $39 million. Even for a destroyer escort vessel, a recent overhaul cost, including some necessary alterations work, was over $8 million. Only the largest private shipyards have these resources.

Table 3, Part B shows the number of qualified private yards capable of Navy ship construction, and their maximum potential employment level. MARAD has determined that of the 202 U.S. shipyards that responded to the MARAD questionnaire, only 25 could be considered shipbuilding yards. Of these 25, three private shipyards are capable of building nuclear submarines and one yard has the capability and capacity to build a nuclear-powered cruiser or aircraft carrier.

FY 1974 financial data reveal the concentration of Navy shipwork among private shipyards.[1] Tables 4 and 5 show that in FY 1974 the Navy paid a total of $1,621 million to private shipyard contractors for work performed or costs incurred.[2]

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[1]Roughly the same pattern of concentration prevails for fiscal years 1972 and 1973. IDA did not attempt to develop extensive historical data on concentration of work. The examination was limited to three years to identify only recent patterns.

[2]Shipbuilding and repair contractors are normally paid based on work completed (progress payments). SSBN conversions, however, were performed under cost type contracts, so, for this work, payments were made on a cost incurred basis.

Table 4. PAYMENTS TO PRIVATE SHIPYARDS FOR NAVY SHIP CONSTRUCTION AND CONVERSION, FY 1974

(In millions of dollars)

Contractor	Dollars Paid	Percent of Total
Ingalls Shipbuilding Company	601.4	46.1
Newport News Shipbuilding and Drydock Company	375.9	28.8
Electric Boat Division	231.7	17.8
All Others	95.7	7.3
Total	1,304.7	100.0

Source: Data provided by the NAVSEA SUPSHIP Management Division, July 8, 1975.

Of this amount, $1,305 million was for new ship construction and conversions and $316 million for alterations and repairs. These payments covered costs of labor and contractor-furnished material. Costs of government-furnished material and equipment are excluded.

Table 4 shows, by contractor, the actual payments by the Navy for ship new construction and conversions. Three contractors received almost 93 percent of the funds paid for this type of shipyard work.

Table 5 lists the 16 private shipyards that received $5 million or more in FY 1974 for Navy ship repairs and alterations. These sixteen yards received 64 percent of all Navy ship repair and alteration work assigned to the private sector. Five of these yards received $10 million or more each in Navy repair and alteration work,[1] and performed 43 percent of the

[1] This includes Jacksonville Shipyards, Inc., which, in fact, received $9,906,000.

Table 5. PAYMENTS TO PRIVATE SHIPYARDS FOR NAVY SHIP REPAIRS AND ALTERATIONS, FY 1974

(In millions of dollars)

Contractor	Dollars Paid	Percent of Total
Electric Boat Division	67.4	21.3
Ingalls Shipbuilding Company	28.6	9.1
National Steel and Shipbuilding Company	18.8	5.9
Alabama Drydock and Shipbuilding Company	12.3	3.9
Jacksonville Shipyards, Inc.	9.9	3.1
Norfolk Shipbuilding and Drydock Company	8.1	2.6
Coastal Drydock and Repair Company	7.8	2.5
Triple "A" South (San Diego)	7.7	2.4
Campbell Industries	7.5	2.4
San Diego Marine Construction	6.6	2.1
Triple "A" Machine Shop, Inc.	6.4	2.0
Maryland Shipbuilding and Drydock Company	6.0	1.9
Northwest Marine Iron Works	5.9	1.9
Metro Machine Company	5.4	1.7
Todd Shipyards, San Pedro	5.3	1.7
Horne Brothers, Inc.	5.1	1.6
All Others	107.0	33.9
Total	315.8	100.0

Source: Data provided by the NAVSEA SUPSHIP Management Division, July 8, 1975.

total Navy program. These data show that most of the Navy ship repair and alteration work is performed by a relatively few yards.

3. Major Categories of Shipyards

Based on a review of MARAD and Navy Shipyard data, we have concluded that the United States has roughly four major categories of industrial activities in its shipbuilding and repair industry. They are as follows:

(1) The naval shipyards that perform ship depot maintenance work of all types, from the simplest to the most complex, and on all sizes and classes of ships. Four of these yards also have some capability to perform new consturction, if required.

(2) About 25 private shipyards that can perform ship new construction and relatively comprehensive repair work on commercial vessels. Within this group is a much smaller number of shipyards that can perform Navy ship new construction and depot maintenance on Navy combatant ships.

(3) About 37 private shipyards that do not have a new ship construction capability but can perform relatively complete repair work on commercial vessels. Companies in this group can perform depot maintenance on some noncombatant Navy ships.

(4) All other United States private shipyards. These shipyards can perform repair work on commercial vessels although for many of these yards this must be done as subcontractors for specific operations. Shipyards in this category have limited capability to perform depot maintenance work on Navy ships.

D. CHARACTERISTICS AND FINANCING OF UNITED STATES NAVY SHIPYARD WORK

Navy shipwork requiring the use of a shipyard type industrial activity includes new construction, conversion, alteration, and repair. The term overhaul is often used for one type of repair work performed on Navy vessels in a shipyard. Overhaul is a periodic repair activity that may include

some modernization work during the period when the ship is undergoing repair.

1. New Construction

Ship new construction includes all functions required to design, build, and outfit or equip a Navy ship with all its subsystems, and deliver the ship to the Navy. Design involves the application of naval architecture and engineering skills to prepare comprehensive plans for construction of all elements of the complete vessel. Design of new Navy ships is usually accomplished by the Navy Ship Engineering Center, with assistance from various private engineering firms under contract.

The shipyard, as an industrial activity, is most heavily involved in the building and outfitting phases of the total ship new construction process. The building phase is largely a steel processing operation involving hull-erection and assembly of fabricated steel sections into a basic structure that can accommodate the machinery, equipment, and related components required to constitute a complete ship. In the building phase, material-flow controls the pace of the work. The limiting factor that determines progress is the amount of steel in tons-per-day that can be processed.

The outfitting phase generally follows the hull-erection stage, although some outfitting work can be initiated during hull-erection. Outfitting involves the installation of all machinery and equipment to complete the ship. In outfitting, the pace of work is controlled by the sequence in which the various installation operations must be performed, and the availability of different labor skill groups to do the work.

Navy ship new construction is financed from the Shipbuilding and Conversion, Navy (SCN) appropriation, a multi-year appropriation. The Congress usually appropriates in a given year all funds required to build a particular ship; these

funds can be expended progressively over a period of years until the ship is completed.

2. Conversions

Navy ship conversions are also financed from the SCN appropriation. Conversions accomplish important changes in the basic capabilities of a Navy ship. Normally, they involve major upgrading of existing ship capability or providing capabilities to perform new missions. For example, in recent years Navy destroyers have been converted to employ missile systems rather than guns, thereby providing a new and greater Navy combat capability.

During conversion, the repair work normally accomplished in an overhaul is also performed concurrently with the conversion. Historically, repair work has represented 45 to 85 percent of the total cost of all work accomplished on Navy ships during the period of conversion.

3. Alterations

Ship alterations upgrade the capabilities of a ship by changes in ship equipment or configuration, but do not change the basic ship mission and do not result in large increases in combat capability. Thus, they are much narrower in scope than conversions. Alterations are normally accomplished during a regular ship overhaul and during conversions. Special design and equipment procurement costs associated with an alteration are financed under the aegis of the Fleet Modernization Program from the Other Procurement, Navy (OPN) and Weapons Procurement, Navy (WPN) appropriations. Common material and labor installation costs are financed from the Operations and Maintenance, Navy appropriation (O&MN).

4. Repair

Navy ship depot repair work is financed by the O&MN

appropriation and encompasses the following kinds of shipyard work:

(1) Regular overhauls. Availabilities[1] for the accomplishment of general repairs and alterations at a shipyard or other shore-based repair activity; normally scheduled in advance and according to an established cycle.

(2) Restricted availabilities. Availabilities for the accomplishment of work which cannot be postponed until the ship's next regularly scheduled overhaul, during which period the ship is rendered incapable of fully performing its assigned mission due to the nature of the repair work.

(3) Scheduled restricted availabilities. Planned restricted availabilities that are formally included in a shipyard schedule.

(4) Technical availabilities. Availabilities for the accomplishment of specific items of work by a repair activity, normally with the ship not present in the shipyard, during which period the ship's ability to fully perform its assigned mission is not affected by the nature of the repair work.

(5) Emergency voyage repairs. Emergency work necessary to enable a ship to continue on its mission that can be accomplished without requiring a change in the ship's operating schedule or the general steaming notice in effect.

This paper is concerned primarily with Navy ship alteration and repair work. Both of these categories of work are considered depot maintenance as defined by DoD Directive 4151.16; however, other categories of work such as new construction and conversions will be addressed to some extent in this paper.

Ship depot maintenance work is quite different from new construction, although the same labor skills are required to

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[1]Definitions of the availabilities are from the NAVSEA *Ship Repair Contracting Manual*, 1974 Edition, and Annex D to the Navy *POM*, FY 1976-80. An availability is a period when intermediate or depot level maintenance personnel have access to the ship to perform required work that is beyond the capability of the ship's force.

perform both types of work. As mentioned above, new construction is largely a steel processing activity until the final outfitting stage. Depot maintenance, however, is primarily a job-shop operation. Individual systems and components must be repaired in-place or removed and repaired in specialized shops. Ship depot maintenance, therefore, does not lend itself to production line processes with the possible exception of work on components within the shipyard shops.

Some Research and Development (RDT&EN) funds are expended in naval shipyards since a limited amount of special ship research work is performed therein. The Military Personnel (MPN) appropriation finances the pay and allowances of the small number of Navy officers and enlisted personnel on duty in the shipyards.

E. NUCLEAR AND NON-NUCLEAR WORK

The United States Navy is equipped with both nuclear and non-nuclear powered ships whereas commercial vessels are currently all non-nuclear powered. The existence of nuclear powered vessels in the Navy has important effects upon the Navy ship depot maintenance program and the shipyards required to accomplish that program.

Extensive detailed information would be required to permit a thorough consideration of both nuclear and non-nuclear depot maintenance workloads and develop answers to questions such as:

(1) What are the differences in organizations, facilities, equipment, and manpower skills required to do nuclear as opposed to non-nuclear work?

(2) What are important factors to be considered in comparing new construction and depot maintenance on nuclear and non-nuclear vessels?

(3) Are there important differences in productivity measures and overhead relationships between nuclear and non-nuclear work?

The authors did not gain access to detailed information on nuclear costs, workloads, and other industrial factors; therefore, we used routinely available information from unclassified documents. These documents permitted a fairly thorough analysis of non-nuclear workload factors, but only a limited amount of analysis related to nuclear workloads.

Chapter II

DIFFERENCES AMONG FACTORS FOR NEW CONSTRUCTION VERSUS DEPOT MAINTENANCE IN NAVAL AND PRIVATE SHIPYARDS

This chapter describes the organization, facilities, and manpower skills in naval and private shipyards and analyzes the differences in these three factors as they pertain to new construction or ship depot maintenance. The chapter is arranged in three sections: organization, in naval and private shipyards; facilities, naval and private; and manpower skills, naval and private. In each section the order of discussion is as follows: non-nuclear repair, nuclear repair, repair and new construction, or new construction only.

A. ORGANIZATION

1. Navy Management

The organization of Navy management from the Secretary of the Navy to the commanders of the eight naval shipyards is depicted in Figure 1. The shipyard commanders report to the Deputy Commander for Industrial and Facility Management, Naval Sea Systems Command (NAVSEA). Five divisions within the Industrial and Facility Management Directorate are responsible for facilities and equipment planning, activity workloading and resources planning, performance evaluation, industrial activity management, and management of the Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP) activity. The SUPSHIP performs contract administration and other tasks related to contract work placed with private shipyards.

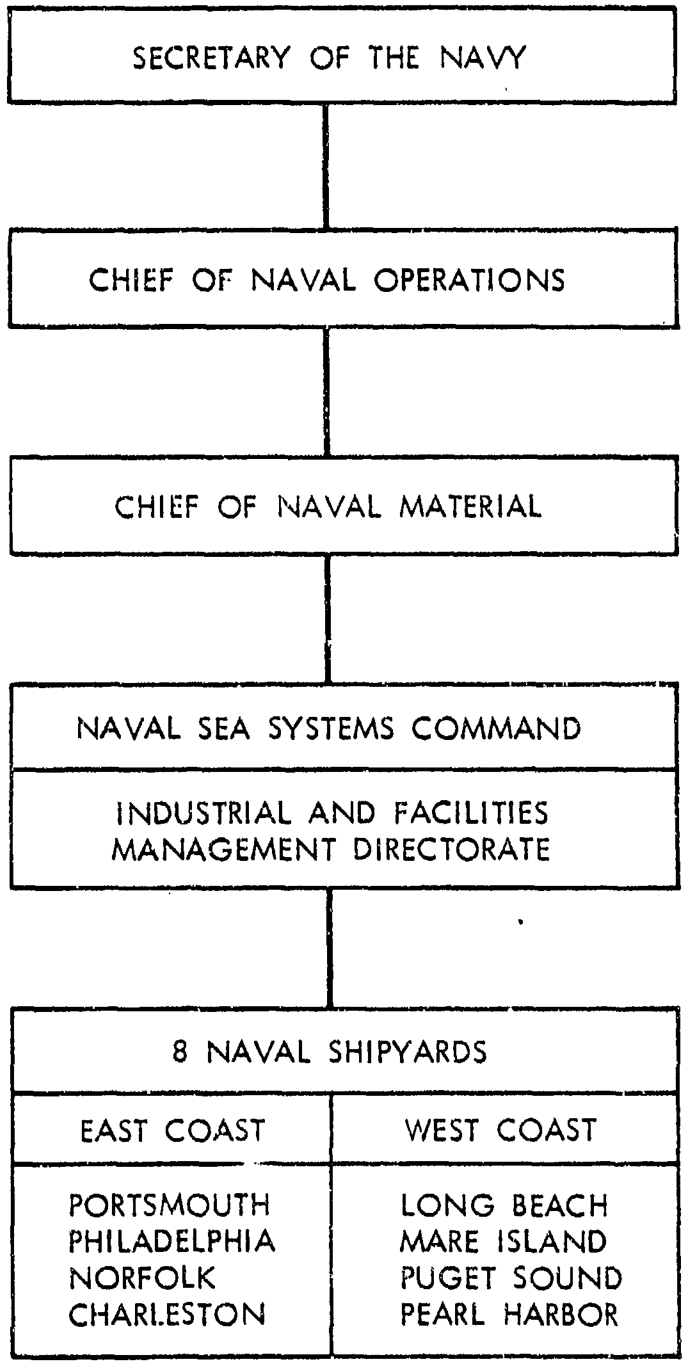

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Figure 1. ORGANIZATION OF NAVY MANAGEMENT

Directions to naval shipyard commanders may come from other than the NAVSEA Deputy Commander for Industrial and Facility Management. For example, the Deputy Commander for Plans, Programs, and Financial Management/Comptroller exercises direction in the area of industrial fund accounting. Important policy matters are usually approved by the Commander, NAVSEA.

Naval shipyards are managed under the Navy Industrial Fund (NIF). As discussed in Chapter I, the NIF is designed to provide a producer-customer relationship similar to that found in private industry. Under the NIF, the naval shipyard commander has a break-even financial objective for operations in each fiscal year. On the other hand, management of private shipyards, under most conditions, is profit-motivated. The most common measure of the private shipyard manager's performance is the profit and loss statement.

2. Organization of Naval Shipyards

The eight naval shipyards are engaged exclusively in depot maintenance.[1] The basic naval shipyard organization is prescribed by NAVSHIPSINST 5450.14C, which requires that each naval shipyard be organized in accordance with standard structural and functional organization charts.[2] Deviations or exceptions to this standard organization must be approved by NAVSEA. Each naval shipyard is authorized to establish subordinate organizational components, as required, below the level depicted in the organization manual.

The organization manual also states the mission of the naval shipyards and identifies the assigned tasks and functions

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[1] The last ship to be built in a naval shipyard was authorized in FY 1966 and completed in April 1972 by the Mare Island shipyard.

[2] NAVSHIPS Instruction 5450.14C, "Standard Naval Shipyard Organization," 1 June 1971. The Naval Sea Systems Command is the successor organization to the Naval Ship Systems Command.

to be accomplished in support of the official mission. (Appendix A, derived from the organization manual, lists the naval shipyard mission, tasks, and functions.) Specific tasks and functions are assigned by letter, directive, message, work request, interservice support agreement, purchase order, or project order.

The specific tasks and functions assigned to each naval shipyard were examined in the course of this study and found to fall within the tasks and functions assigned in the organization manual. The Financial and Operating Statements were examined for fiscal years 1960 through 1974 to determine the mix of work the shipyards were performing in support of their assigned missions. The breakdown of major categories of work (new construction, conversion, overhaul and repair, alterations, other shipwork, and non-shipwork)[1] is shown in Figure 2. The four naval shipyards (Portsmouth, Philadelphia, Mare Island, and Puget Sound) that have been heavily engaged in new construction and conversion display more volatile relationships among the major categories of work than do those that have been oriented more to overhaul and repair. All of the shipyards shown in Figure 2 display accrued costs for new construction, even those that have never built ships. These costs are for fitting out and post-shakedown availabilities, and minor construction, which are financed in the Shipbuilding and Conversion, Navy appropriation. All shipyards that previously performed new construction have had significant changes in workload mix following the Navy's decision (1966) to place all new construction in private shipyards. (For a more detailed breakdown of workload mix by dollar volume and as a percentage of the total dollar volume, refer to Appendix B.)

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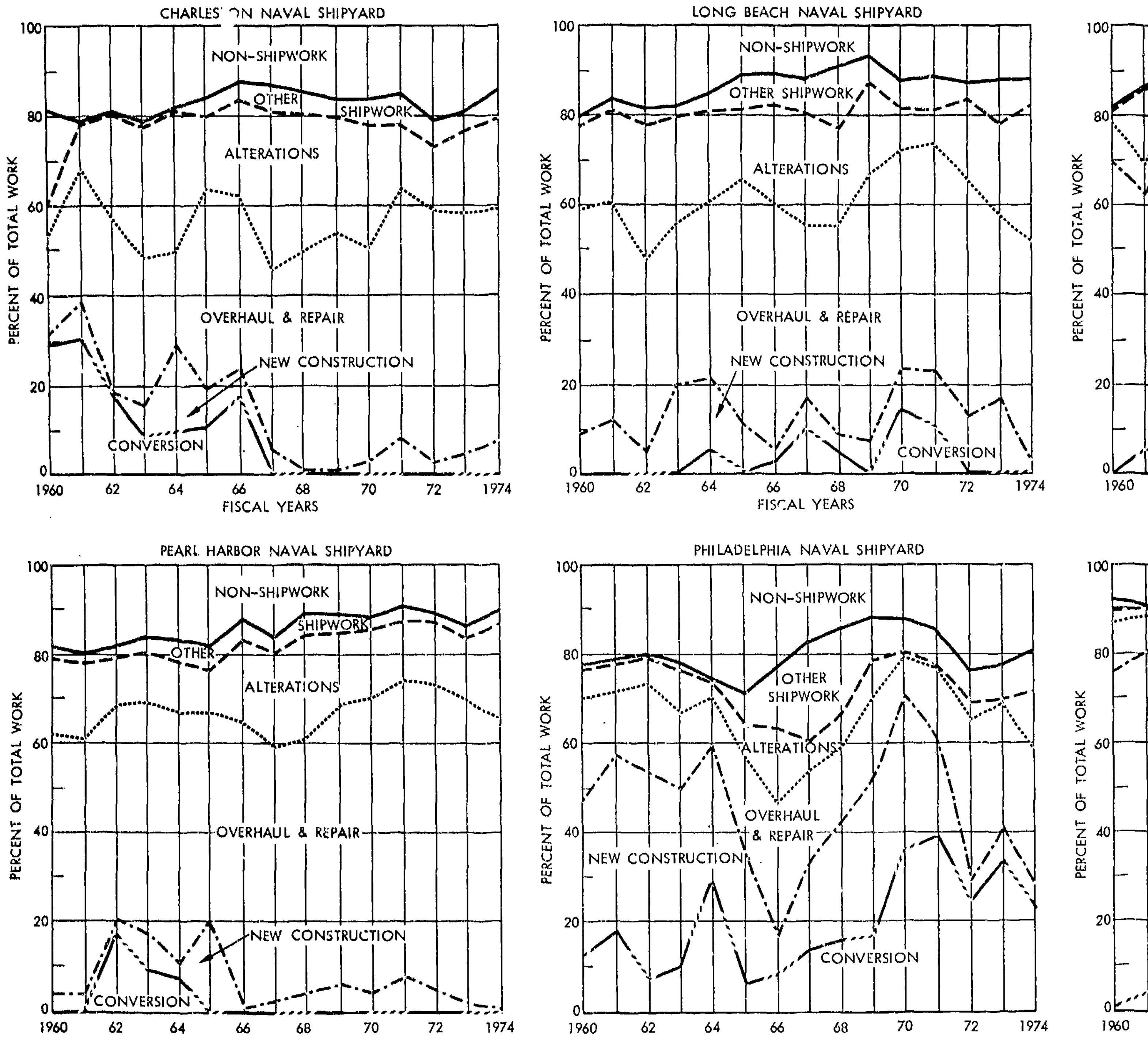
[1]Alterations are normally performed during overhauls, but the accounting system collects cost data in a manner that identifies alteration work as a separate category.



Note: Appendix B contains detailed data on accrued costs by naval shipyard.

[1]During fiscal years 1967 through 1969 Mare Island and Hunters Point Naval Shipyards were combined into the San Francisco Bay Naval Shipyard; thus this portion of the graph does not reflect Mare Island alone, but both Hunters Point and Mare Island.

Source: Navy Industrial Fund Financial and Operating Statements of above Naval Shipyards, Fiscal Years 1960-1974.

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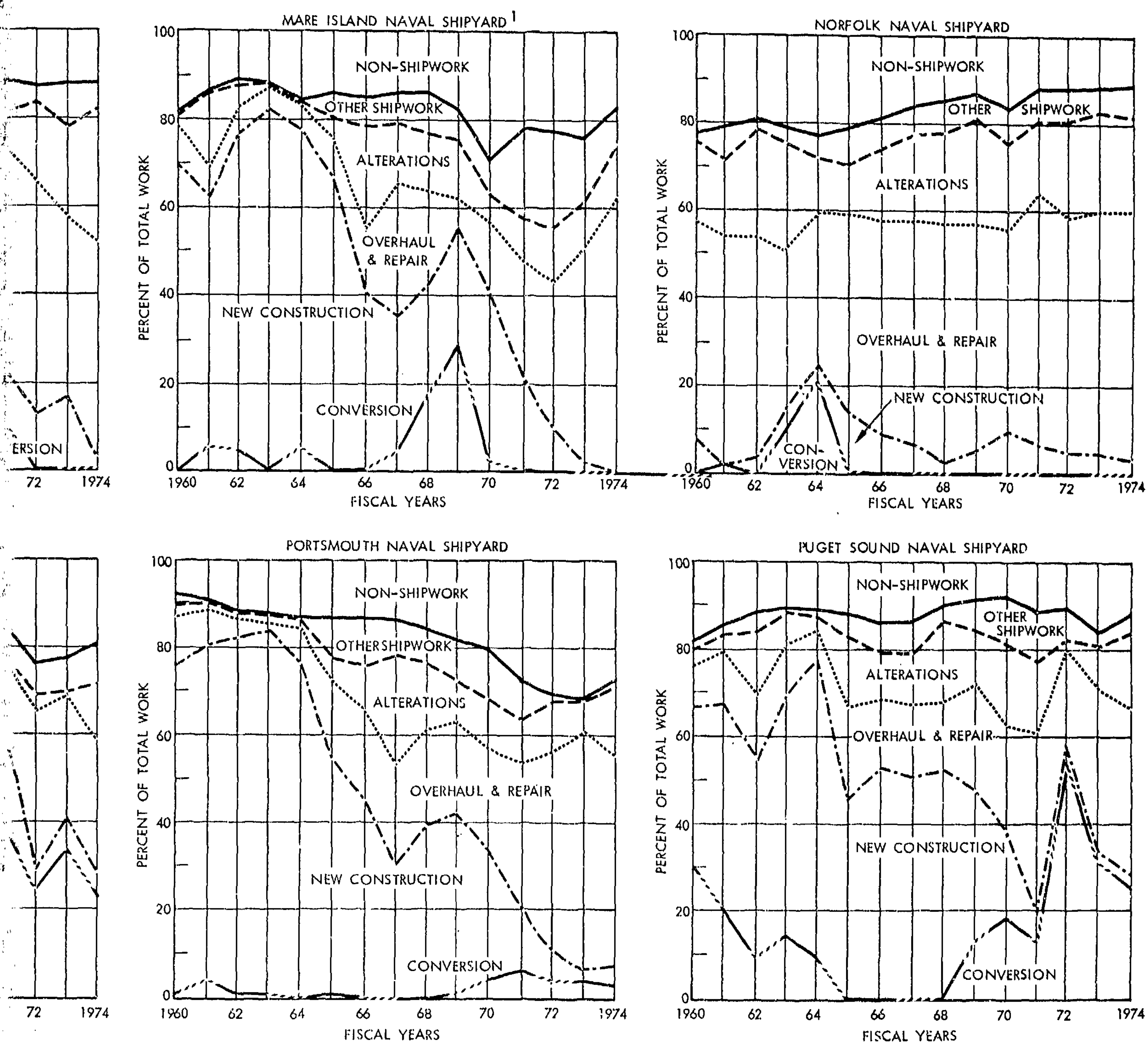


Figure 2. PERCENTAGE DISTRIBUTION OF ACCRUED COSTS OF SHIPYARD WORK BY NAVAL SHIPYARD - IN CURRENT DOLLARS

Definition of Shipyard Work Categories

New Construction	Includes the building, fitting out, and post-shakedown availabilities of new ships. This category includes the costs relating to new ships financed in the Shipbuilding and Conversion, Navy appropriation.
Conversion	Includes the costs of major modifications, alterations to modernize and improve the capabilities of ships, and the repairs made during the conversion. All costs are financed in the Shipbuilding and Conversion, Navy appropriation.
Overhaul and Repair	Includes the costs for regular overhaul and repair of active and reserve fleet ships, naval reserve training ships, and Military Sealift Command and MAP ships. Repair includes voyage repairs, restricted availabilities, and technical availabilities.
Alterations	Includes the costs of performing alterations approved by NAVSEA, type commanders, or other authorities on the same categories of ships listed above.
Other Shipwork	Includes inactivation and reactivation; ship disposal; research and development related to ships; design work for construction, conversion, alteration and overhaul, refit and restoration; and some ship-related manufacturing.
Non-Shipwork	Includes manufacturing for NIF stores, the Navy Stock Fund, and the Defense Stock Fund; repairs to material in stores; overhaul and repair of non-ship items; non-ship related research and development; additions and improvements to the plant; and support of tenants and satellites.

Figure 2. (cont'd)

a. Non-Nuclear Repair

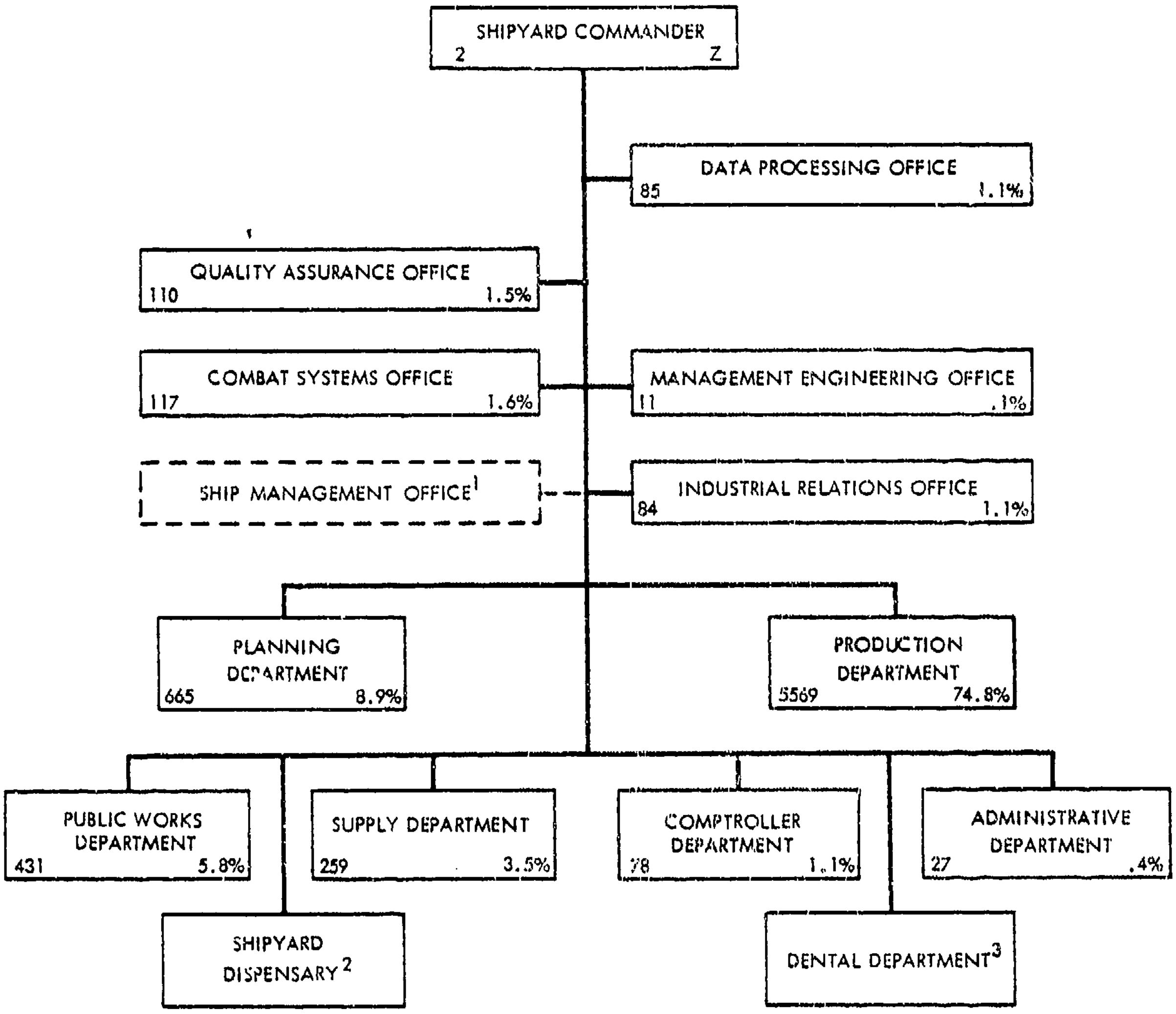
All eight naval shipyards perform non-nuclear repair; however, Philadelphia and Long Beach perform only non-nuclear repair. The standard naval organization for non-nuclear repair yards (see Figure 3) has five offices and eight departments reporting to the shipyard commander. A sixth office may be added whenever a Ship Management Office is established.[1] A Ship Management Officer is a special project officer assigned to ensure that all repair functions are properly coordinated and performed on a particular major overhaul or repair operation assigned to the shipyard. Descriptions and responsibilities of the various offices and departments in the standard naval shipyard organization are contained in Appendix C.

Personnel distribution data displayed in Figure 3 are for the Long Beach Naval Shipyard as of June 30, 1974. These data illustrate the relative size of various activities in naval shipyards. No number or percentage is shown in the Ship Management Office block as this office is activated only on an "as required" basis.

The Production Department (see Figure 4) is the largest department in a shipyard, employing from two-thirds to three-fourths of the shipyard's employees. The majority of the direct labor employed to accomplish the repair workload comes from this department. Cited below are major responsibilities of key officials in this department (a detailed list of the responsibilities of these officials is given in Appendix D):

- The Repair Officer is responsible for non-nuclear ship and shop work including manpower requirements, production control, test coordination, and docking and undocking of ships.

[1]Appendix I to NAVSHIPSINST 5450.14C sets forth the criteria for establishing Ship Management Officers.



Note: Numbers in blocks show personnel distribution at Long Beach Naval Shipyard, 30 June 1974.

Z = less than 1/10 of 1 percent

[1] Chartered by the shipyard commander as required when meeting the criteria set forth in NAVSHIPS Instruction 5450.14C. The number of personnel assigned to the office has varied from one to twenty four.

[2] The naval shipyard dispensary is a designated component of a Naval Regional Medical Center. Personnel are charged to the center. The dispensary Senior Medical Officer has additional duty to the shipyard commander.

[3] The Dental Department is a designated component of a Naval Regional Dental Center. Personnel are charged to the center. The Senior Dental Officer in the shipyard has additional duty to the shipyard commander.

SOURCE: NAVSHIPSINSTRUCTION 5450.14C and Statistics of Naval Shipyards, June 1974.

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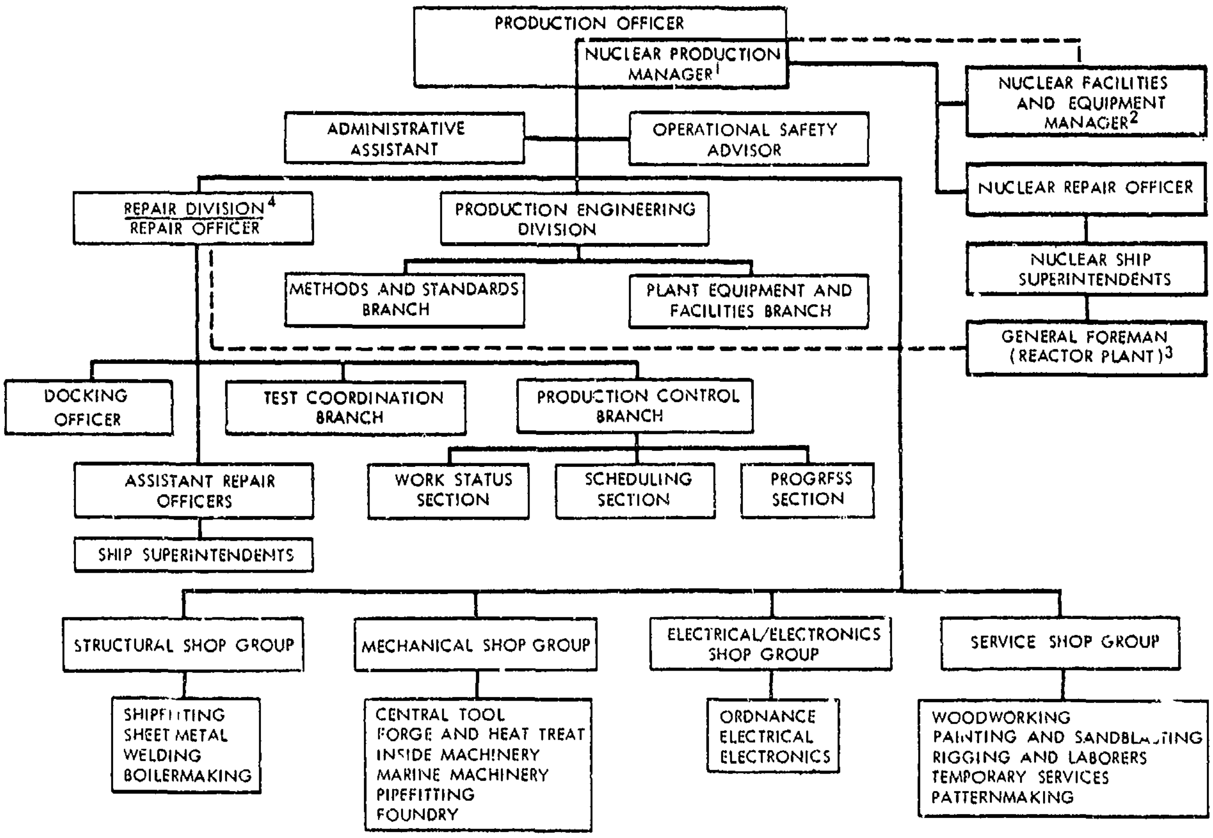
Figure 3. NAVAL SHIPYARD ORGANIZATION (NON-NUCLEAR REPAIR)



[1] Has direct access to the shipyard commander on nuclear matters.

[2] Has direct access to the shipyard commander and production officer on nuclear matters. This is a single position double billeted in the Production and Public Works Departments.

[3] Reports to the repair officer on matters of ship protection from fire, flooding, and other matters not involving nuclear reactor safety.

[4] The Repair Division may be titled Shipbuilding and Repair Division when new construction is assigned to the shipyard.

SOURCE: NAVSHIPSINSTRUCTION 5450.14C.

5-14-75-16

Figure 4. ORGANIZATION OF A NAVAL SHIPYARD PRODUCTION DEPARTMENT (Repair Only)

- The Production Engineeering Officer is responsible for developing and maintaining labor standards; improving production processes, methods and practices; designing special tools, jigs and fixtures; and improving and modernizing industrial facilities, equipment, and tools.
- The responsibilities of the Shop Group Superintendents are to develop, train, and maintain competent work forces within their respective groups; accomplish all work assigned on time and at reasonable cost; and manage and control overhead operating costs for shops under their control.

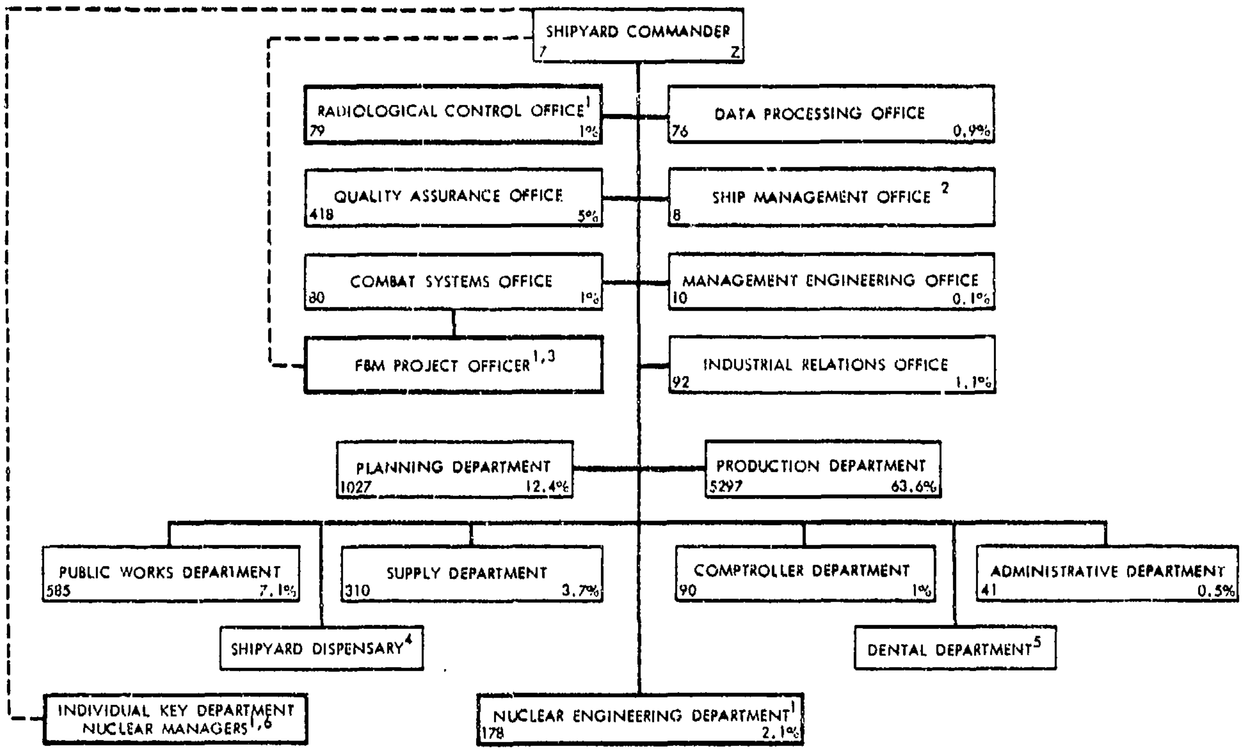
b. Nuclear Repair

Figure 5 depicts the organization of naval shipyards performing both nuclear and non-nuclear repair. The personnel strengths displayed are for the Mare Island Naval Shipyard as of June 30, 1974. Those blocks outlined in heavy lines are the required additions to a basic non-nuclear naval shipyard organization when nuclear work is to be performed (the Radiological Control Office and the Nuclear Engineering Department).[1] In addition, nuclear managers are located in the following departments:

Department	Nuclear Manager
Quality Assurance Office	Nuclear Quality Assurance Manager
Planning Department	Nuclear Planning Manager
Production Department	Nuclear Production Manager Nuclear Facilities and Equipment Manager[2] Nuclear Repair Officer
Public Works Department	Nuclear Facilities and Equipment Manager[2]
Supply Department	Nuclear Material Manager

[1]Also shown in Figure 5 is a Fleet Ballistic Missile Project Officer, who is assigned to the shipyard when FBM submarines are overhauled. For all other ships, the Ship Management Offices accomplish the functions assumed by the separate FBM organizational entity.

[2]This is a single position double-billeted in both the Productio Public Works Departments.



Note: Numbers in blocks show personnel distribution at the Mare Island Naval Shipyard, 30 June 1974.

Z = less than 1/10 of 1 percent

[1]Applies only to naval shipyards performing nuclear work.

[2]Chartered by the shipyard commander as required when meeting the criteria set orth in NAVSHIPS Instruction 5450.14C. The number of personnel assigned to this office has varied from one to twenty-four.

[3]Applies only to naval shipyards designated as FBM shipyards in accordance with NAVSEAINST 9780.17A.

[4]The naval shipyard dispensary is a designated component of a Naval Regional Medical Center. Medical personnel are charged to the center. The dispensary Senior Medical Officer has additional duty to the shipyard commander.

[5]The Dental Department is a designated component of a Naval Regional Dental Center. Personnel are charged to the center. The Senior Dental Officer in the shipyard has additional duty to the shipyard commander.

[6]Department Nuclear Managers have direct access to the naval shipyard commander on nuclear matters and are located in the Quality Assurance Office, Planning, Production, Public Works, and Supply Departments.

SOURCE: NAVSHIPSINSTRUCTION 5450.14C and Statistics of Naval Shipyards, June 1974.

5-14-75-17

Figure 5. ORGANIZATION OF NAVAL SHIPYARDS (NON-NUCLEAR AND NUCLEAR REPAIR)

Some of the departmental nuclear managers have additional discrete components reporting to them. The Nuclear Quality Assurance Manager has a Nuclear Inspection Division. A Nuclear Type Desk Officer reports directly to the Nuclear Planning Manager on nuclear matters. Under the Nuclear Production Manager are the Nuclear Facilities and Equipment Manager and the Nuclear Repair Officer. This latter officer supervises the Nuclear Ship Superintendents and General Foreman of the Reactor Plant. (Appendix E provides organization charts and additional information on the responsibilities assigned to the cognizant nuclear managers.)

c. Repair and New Construction

The basic organization at the department level in a naval shipyard is the same regardless of whether the workload is all repair or repair plus new construction. Within a department, organizational changes may take place to reflect such factors as the type of building program, management philosophy, and whether there is a work force dedicated to new construction. In the Planning, Supply, and Quality Assurance Departments, for example, additional personnel would be needed to support a shipbuilding program. Whether the repair and new construction functions are integrated within a department is a management decision. Some Navy officials prefer an integrated organization; others favor two parallel organizations.

The Production Department, which would be most affected by the need to undertake both repair and shipbuilding, provides an example for examining the integrated and parallel organization approaches. (Figure 4 displayed the Production Department organization of naval shipyards engaged in repair only.)

The Repair Division is the main Production Department component affected by the addition of new construction. The *Standard Naval Shipyard Organization Manual* prescribes that this division be titled the Shipbuilding and Repair Division

when new construction work is assigned. Figure 6 provides two alternative Production Department organizational structures for adding new construction to naval shipyard work. In the integrated approach, the existing repair-oriented organization would be essentially retained and the shipbuilding functions performed with that organizational structure (Option A in Figure 6). This option retains the title of Shipbuilding and Repair Division previously mentioned, and splits the new construction and repair functions below this level with assistants and separate ship superintendents for each. In the Production Control Branch, each section would perform new construction and repair functions.

Option B splits the new construction and repair functions at the division level, thereby creating two parallel divisions--one for new construction and one for repair.[1] The Shipbuilding Officer and the Repair Officer would have their own assistants, ship superintendents, Test Coordination Branches, and Production Control Branches. The Docking Officer would remain under the Repair Officer.

Under Option B, the lines of authority are clear, as both the Shipbuilding Officer and the Repair Officer have their own organizations. The lines of authority are less clear in Option A and would require more coordination in scheduling. Under either option, shifting from all repair work to repair and new construction would require more personnel. The number of additional workers would be a function of various factors, e.g., the type of new construction program, its duration, and its priority. Option B would require more supervisory personnel than Option A because of the parallel staffing.

Previously, when both new construction and repair work were performed in naval shipyards, adaptations of both options

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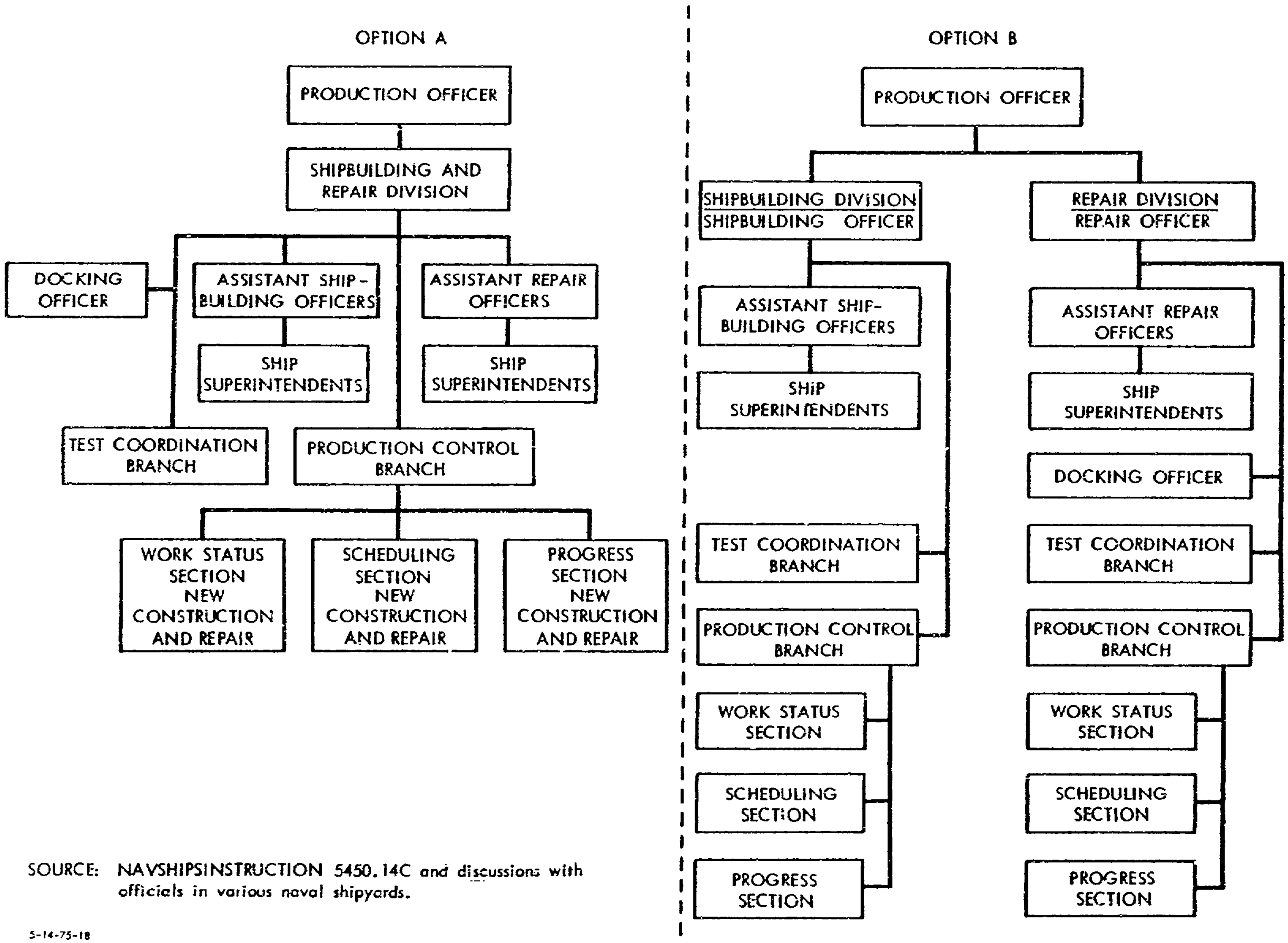
[1]Option B would require an amendment to the *Standard Naval Shipyard Organization Manual.*



SOURCE: NAVSHIPSINSTRUCTION 5450.14C and discussions with officials in various naval shipyards.

5-14-75-18

Figure 6. ORGANIZATION OPTIONS IN THE PRODUCTION DEPARTMENT

were employed. Naval shipyard management officials still remain divided as to which approach should be used. It can be assumed that the approach selected in any future construction program would depend primarily on the policies regarding shipyard management at the time. Either approach is workable.

3. Organization of Private Shipyards

The Departments of Defense and Commerce jointly publish a document titled "Principal Shipbuilding and Repair Facilities of the United States," based on data submitted by private industry on Standard Form 17.[1] This publication provides basic information about industrial activities that fall within the Industry No. 3731, "Shipbuilding and Repairing," classification in the Office of Management and Budget Standard Industrial Classification Manual.[2] Also included are facilities that hold MSRCs, although they may not be included in the Industry No. 3731 classification. The publication lists 257 private shipbuilding and repair activities located within the United States. Of this number, 202 furnished data on their maximum employment; which ranged from 12 to 41,000 employees. Maximum employment potential is an indicator of the size of private shipbuilding and repair activities because all shipyards become facilities-constrained at some level of employment without additional capital investment.

Figure 7 presents the distribution of 202 private shipbuilding and repair facilities according to maximum employment potential. Private shipbuilding and repair activities vary widely in maximum employment potential and, therefore, in size.

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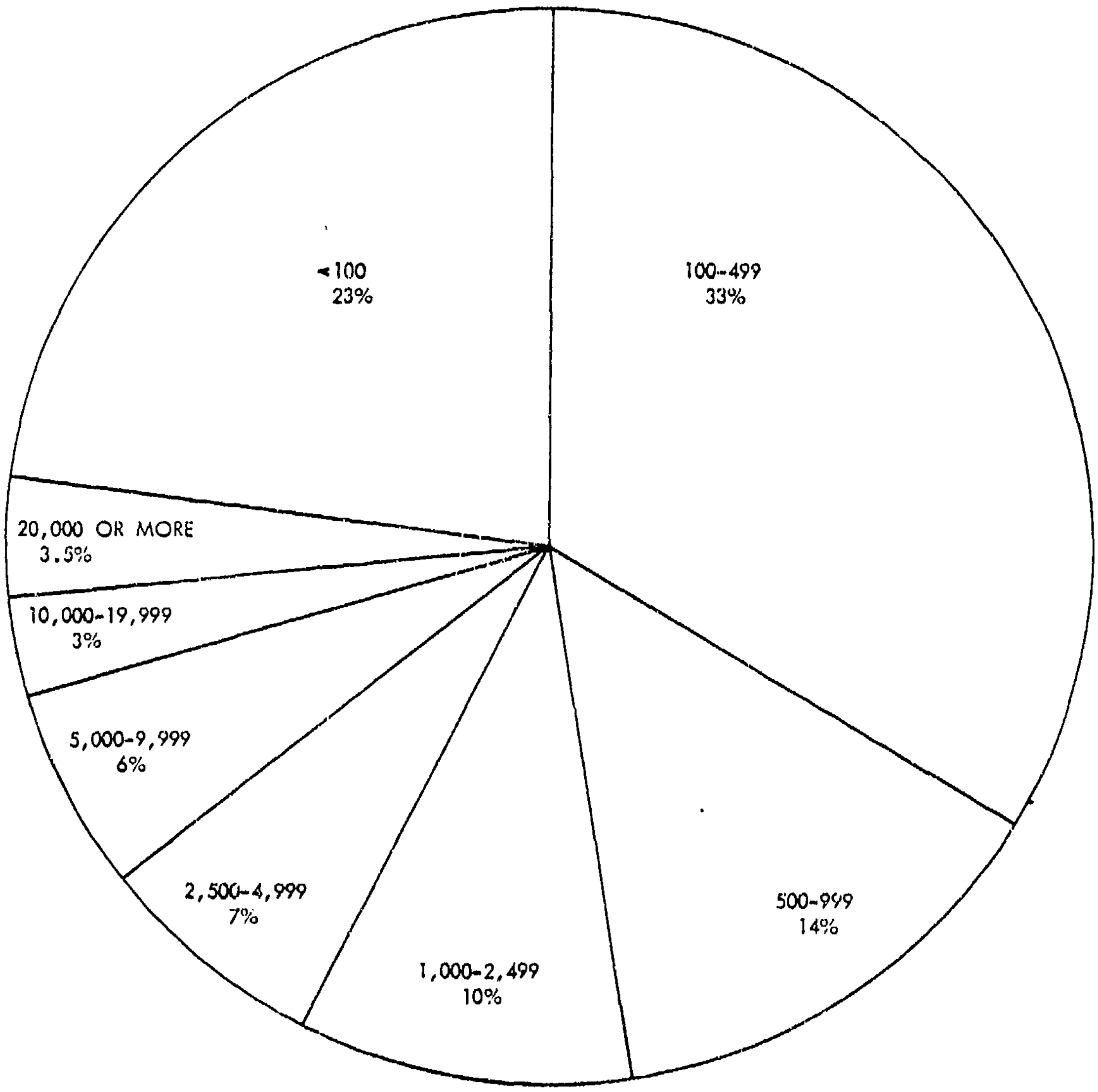
[1]Department of Defense and Department of Commerce, Office of the Coordinator for Ship Repair and Conversion, *Principal Shipbuilding and Repair Facilities of the United States*, Washington, D.C., April 1973.

[2]Executive Office of the President, Office of Management and Budget, *Standard Industrial Classification Manual*, Government Printing Office, 1972.



DATA DISTRIBUTION

POTENTIAL EMPLOYEES	<100	100 TO 499	500 TO 999	1,000 TO 2,499	2,500 TO 4,999	5,000 TO 9,999	10,000 TO 19,999	20,000 OR MORE
NUMBER OF SHIPYARDS	46	67	28	21	15	13	6	7

SOURCE: Principal Shipbuilding and Repair Facilities of the United States.

5-14-75-21

Figure 7. DISTRIBUTION OF 202 PRIVATE SHIPYARDS ACCORDING TO MAXIMUM EMPLOYMENT POTENTIAL

Private shipyards in each of these categories perform repair work for the Navy and are, therefore, considered in this chapter. Emphasis, however, will be on those private shipbuilding and repair activities with a maximum employment potential of 5,000 or more because of their comparability to naval shipyards. There are 26 private shipbuilding and repair establishments involved in this group, about 13 percent of the total.

Private shipyards vary in organizational structure. Some are subsidiary companies within conglomerates or parent companies and are quite formally structured. At the other end of the spectrum are small family-owned companies with much smaller organizational structures. These structures are frequently more informal than in companies that are components of large firms.

The discussion that follows focuses first on the management structure of private shipyards. Figure 8 depicts three alternative organizational arrangements for the top management of private shipyards owned by a parent corporation.

Under Option A, the president and general manager of the private shipyard reports to a senior vice president of the parent corporation. In Option B, the president and general manager of the private shipyard reports either to a vice president for shipbuilding or is dual-billeted as president of the private shipyard and a vice president in the parent corporation.[1] Under Option C, the shipyard company has a chairman and Board of Directors separate from that of the parent corporation. The president of the shipyard may be a member of the board. While these three examples represent the organizational structures of many parent-corporation-controlled private shipyards, other variations exist.

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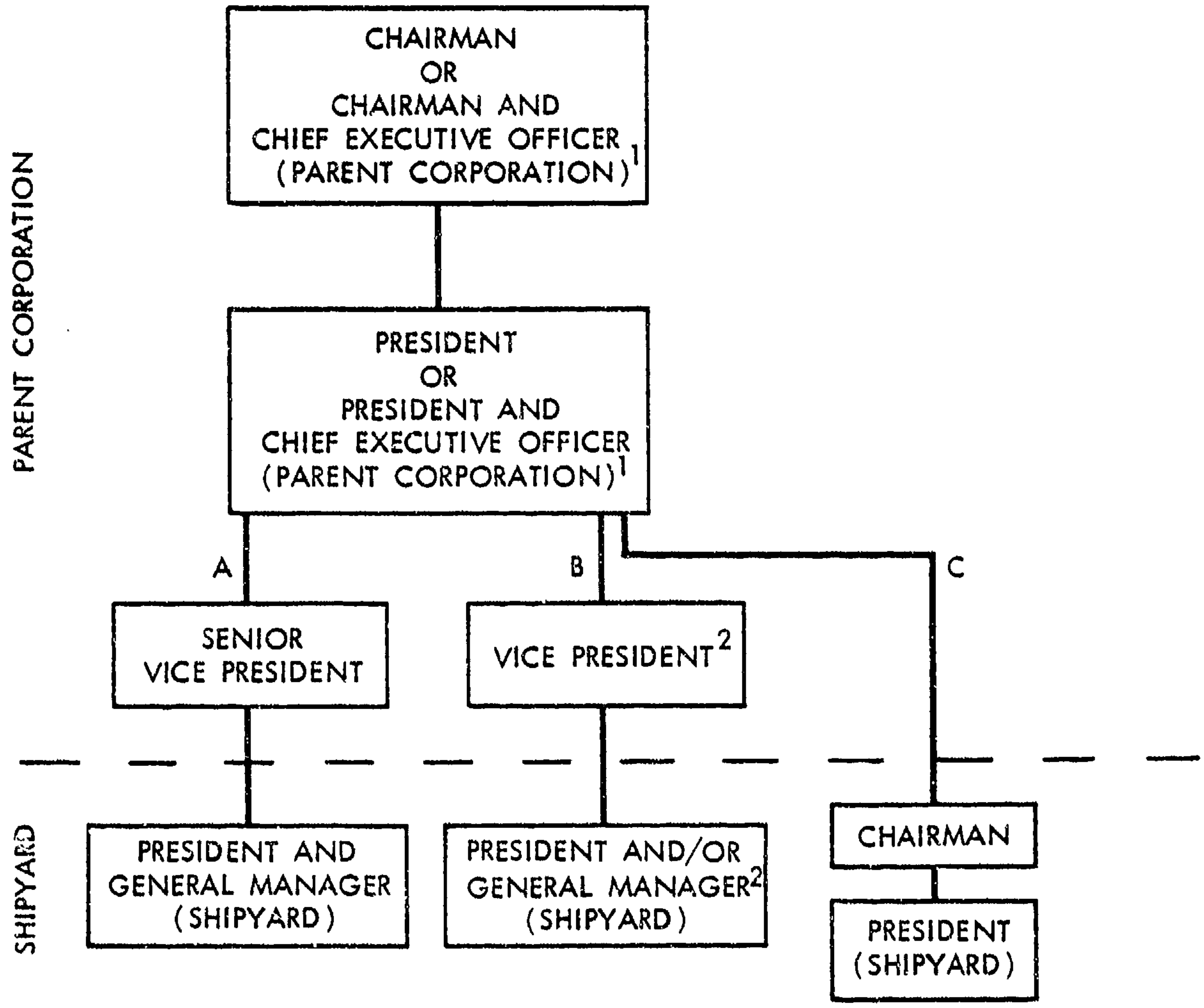
[1]Vice president for shipbuilding is the title used by the corporate organization albeit both shipbuilding and repair are performed in the shipyard.



[1] Either the Chairman of the Board or the President may be designated the Chief Executive Officer. Both situations are found in the private sector.

[2] The Vice President of the parent corporation is often the President and/or General Manager of the shipyard.

SOURCE: Standard and Poor's Register of Corporations, Directors and Executives, 1975, Vol. 1.

5-14-75-19

Figure 8. REPRESENTATIVE ORGANIZATION OPTIONS OF PRIVATE SHIPYARDS OWNED BY PARENT CORPORATIONS

Figure 8 represents the private shipyards' counterpart to the Navy management structure for administration of its shipyard complex as depicted in Figure 1. In some cases, parent-corporation-controlled organizations have several layers of management for administration of their shipyards, similar to the Navy, but without the large staffs that support each Navy management layer.

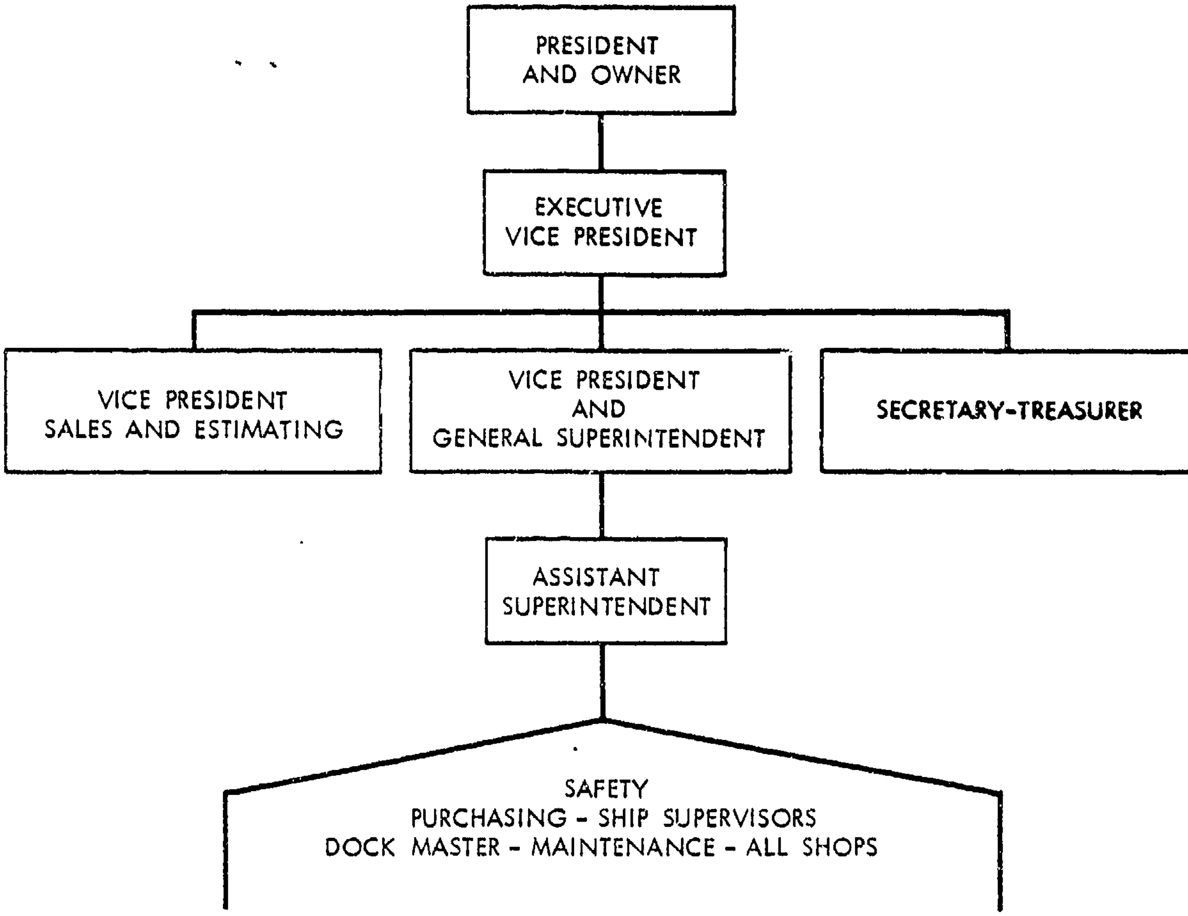
Figure 9 depicts a typical organization for a small private shipyard owned by an individual or family. The owner is the president of the shipyard, and members of the family may occupy other key management positions. If the shipyard owner or a member of his family is not qualified, or does not choose, to operate the shipyard, a vice president and general superintendent/manager, who is expert in shipyard operations, may be employed.

a. <u>Non-Nuclear Repair</u>

The private shipyards in the non-nuclear category are engaged primarily in repair, but they may perform either Navy or commercial new construction to help maintain a more stable workload. Figure 10 depicts a representative organization of private shipyards engaged in non-nuclear repair.

A private shipyard is managed typically by a general manager with six or more subordinates reporting directly to him. In some shipyards, the number of subordinates may be as high as thirteen. The general manager possesses a wide range of freedom in exercising authority. In most cases he determines what kinds of work the shipyard will bid on or for which it will negotiate.

The major line of operating authority passes from the general manager through the general superintendent (also titled yard superintendent, yard manager, operations manager, or production manager) to the shop foremen. In some private



SOURCE: Responses from private shipyards to an IDA questionnaire.

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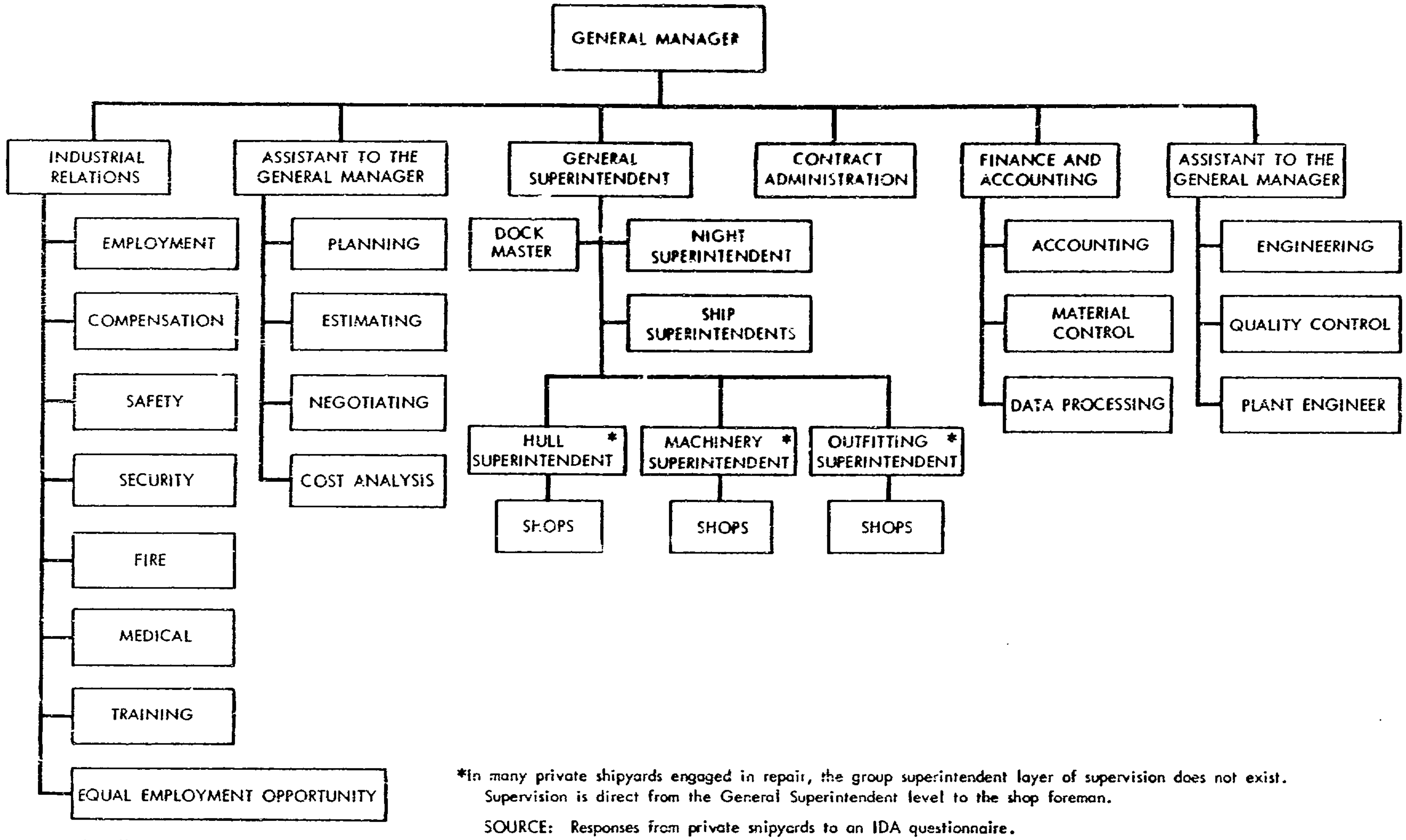
Figure 9. REPRESENTATIVE ORGANIZATION OF A SMALL PRIVATE SHIPYARD

shipyard organizations, this line of authority passes through ship superintendents[1] or supervisors and/or shop group superintendents (most common are hull or structural, machinery, and outfitting superintendents).

[1]Although practices vary among private shipyards, the general rule calls for one superintendent per ship.



*In many private shipyards engaged in repair, the group superintendent layer of supervision does not exist. Supervision is direct from the General Superintendent level to the shop foreman.

SOURCE: Responses from private shipyards to an IDA questionnaire.

5-14-75-22

Figure 10. REPRESENTATIVE ORGANIZATION OF PRIVATE SHIPYARDS ENGAGED IN NON-NUCLEAR REPAIR

b. Nuclear Repair

Three private shipyards are qualified to perform nuclear repairs--Newport News Shipbuilding and Drydock Corporation; General Dynamics, Electric Boat Division; and Litton Industries, Ingalls Shipbuilding Division. All three shipyards have built or are building nuclear-powered ships; thus their organizations include both new construction and repair functions. Their organizations will be discussed below.

c. Non-Nuclear Repair and New Construction

Private shipyards engaged in repair and new construction generally are oriented primarily to one or the other type of work. Those engaged primarily in repair use new construction to stabilize their workload and employment, whereas those that principally build ships use repair work as a filler. Most private shipyards with 5,000 or more employees perform new construction.

Figure 11 displays the organization of a representative private shipyard engaged in repair and new construction. (This figure was developed by comparing the organizations of several private shipyards.) The chief operating official usually has the title of president and/or general manager. Various vice presidents or assistant general managers and heads of department report to him. A discussion of the eight major departments that comprise this representative organizational structure is contained in Appendix F.

The structures of twenty-two private shipyards that provided organizational data in responding to an IDA questionnaire were examined to determine what organizational differences can be attributed to the nature of the work--repair or new construction. The organizational diagrams for four shipyards clearly indicated they were structured to perform repair and new construction; two shipyards' organizational charts stated

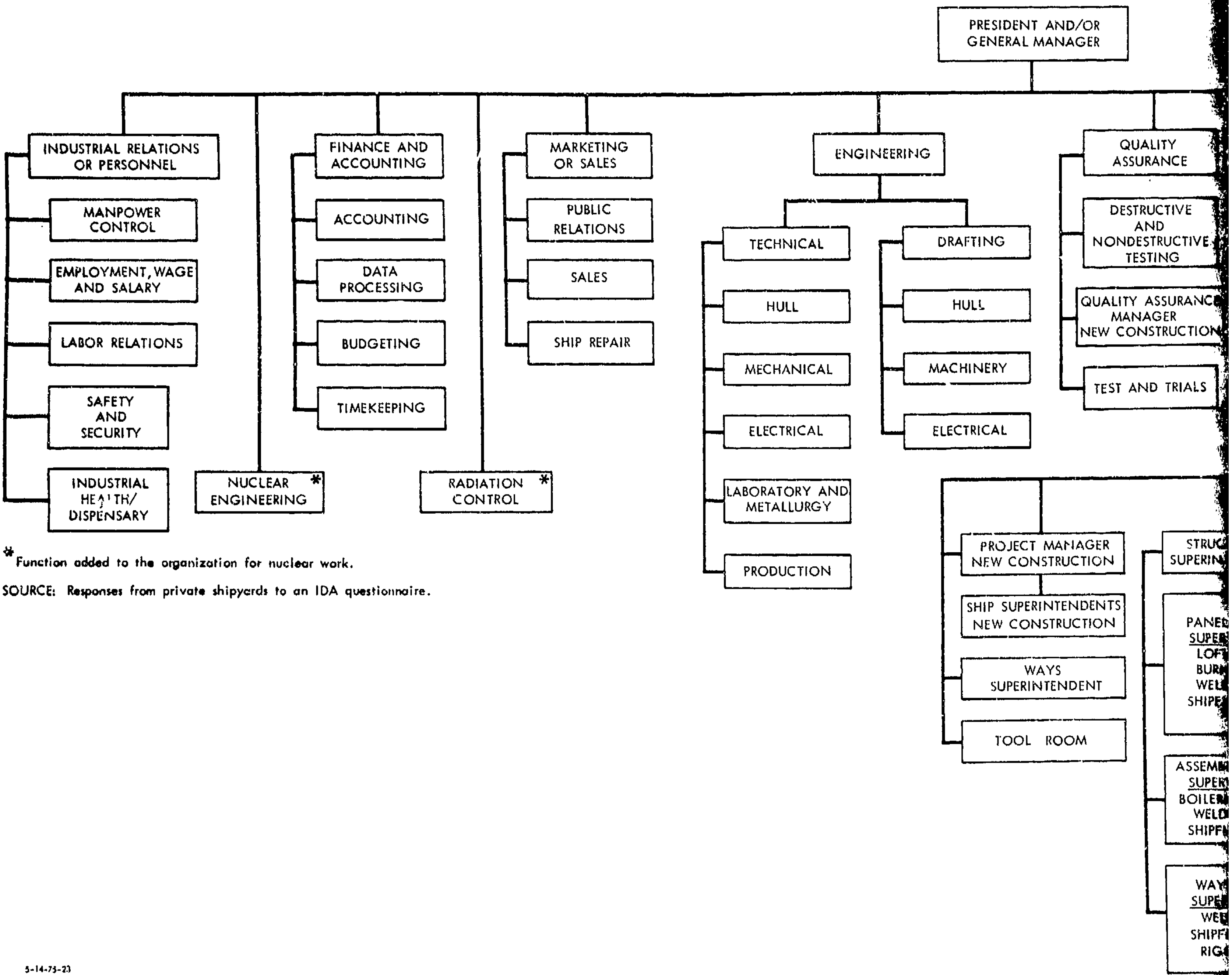
only repair work; and new construction could be inferred from two others. From the organization charts of the remaining fourteen, it could be determined that a shipyard had the general capabilities to perform new construction or repair, but it was not possible to determine what kind of work was being performed.

In those private shipyards clearly organized to perform both repair and new construction, the differences in organization to perform both functions are manifest in several areas. Marketing or Sales has a separate group handling ship repair sales. Estimating and Negotiation divides the new construction and repair functions. A similar split may occur in Quality Assurance. The separation of repair and new construction functions is most obvious in the Operations or Production Department. Under the production manager, repair functions are assigned to a ship repair superintendent and new construction is assigned to a project manager. A separate project manager is assigned for each type of ship and in some cases for each ship. There are separate ship superintendents for repair and new construction.

Because of the unstable nature of their business, most private shipyards maintain relatively small engineering departments. If a private shipyard experiences a significant increase in its new construction workload, the design and engineering functions are subcontracted to an engineering firm. The headquarters of a corporation owning several private shipyards may retain a small central pool for design and engineering. For these reasons, the organization of most private shipyards will not reflect any change arising from new construction since most design engineering is subcontracted.

d. Nuclear Repair and New Construction

The changes in organization arising from the requirement to perform nuclear work cannot be documented completely because



*Function added to the organization for nuclear work.

SOURCE: Responses from private shipyards to an IDA questionnaire.

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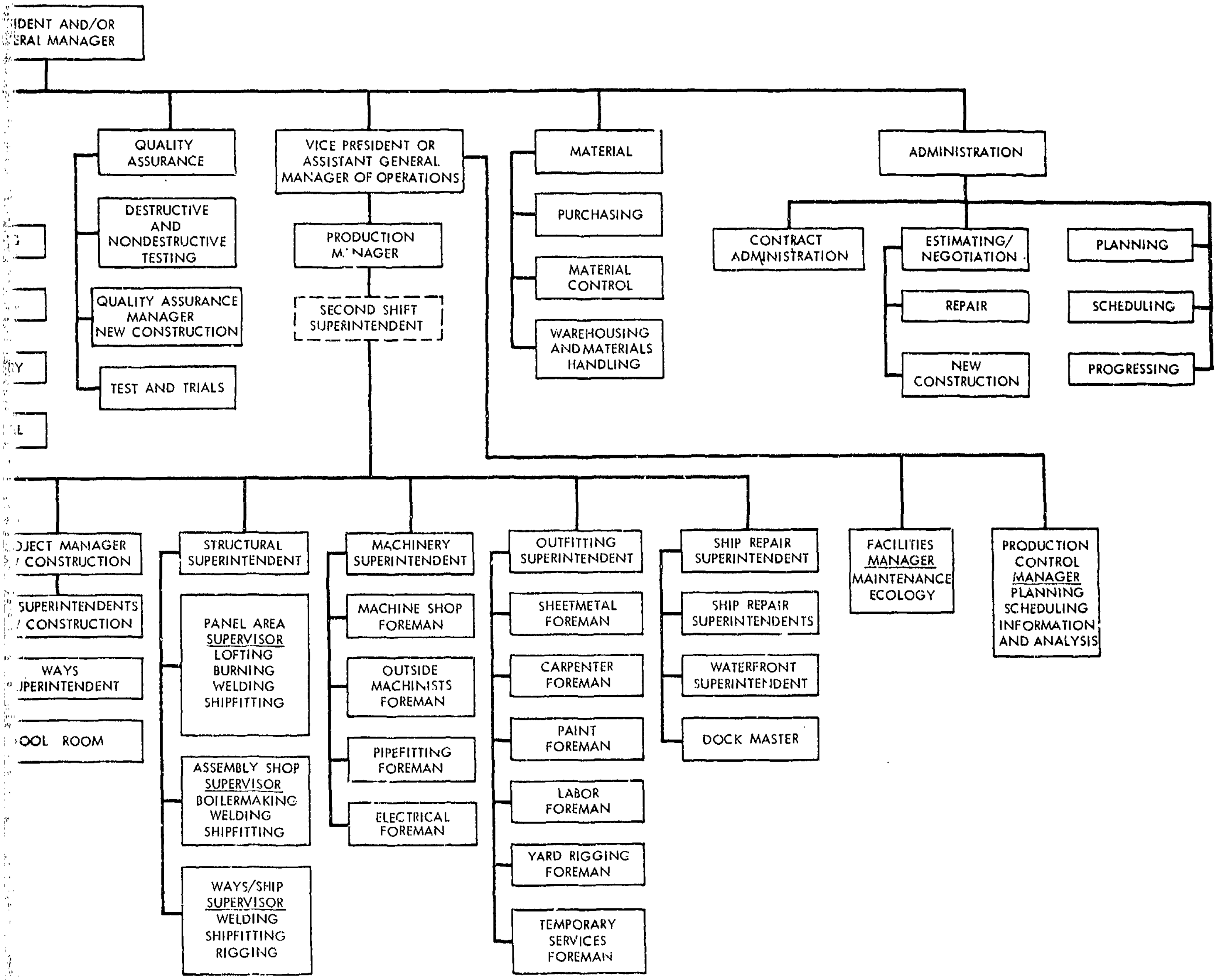

Figure 11. ORGANIZATION OF A REPRESENTATIVE PRIVATE SHIPYARD ENGAGED IN NEW CONSTRUCTION AND REPAIR

IDA did not have access to detailed nuclear information. Since the functions that must be performed to support nuclear work in private shipyards are basically the same as in naval shipyards, it is reasonable to expect activities to exist that are comparable to the Nuclear Power and Radiological Control organizations in naval shipyards. The manpower requirements for these activities are unknown. Additional employees are probably required in Quality Assurance activities since more numerous and detailed inspections are required for nuclear than for non-nuclear work. The number of personnel required to perform this work could not be ascertained.

4. Organization Summary

Naval shipyards are organized according to a standard organization manual and oriented to repair work. Changes to the prescribed structure must be approved by NAVSEA. Private shipyards vary in organization. Their organizational structures tend to reflect the management policies of a parent corporation and the needs of the shipyard in its business environment.

Figure 12 compares the titles of departments and offices of naval shipyards with counterpart organizations in the private sector. Except for a few cases, functions assigned to a naval shipyard department can be found in many different departments in private shipyards.

Placing new construction in naval shipyards would require changes in shipyard organization to provide for the accomplishment of the added functions. These new construction functions could either be integrated into the existing activities or accomplished by creating new organizational entities. The departments most affected by the addition of new construction are Production, Planning, Supply, and Quality Assurance. The number of personnel involved would depend upon the type of new construction program and its duration.

Naval Shipyards	Private Shipyards
Planning Department	Engineering Estimating and Negotiation Administration[1] Engineering and Technical Sales and Estimating Sales Marketing Planning
Production Department	Operations Production Works Yard Operations
Comptroller	Finance Finance and Comptroller Finance and Accounting Financial Operations Treasurer and Accounting Accounting
Supply Department	Material Purchasing[2] Administration (Material Department)
Industrial Relations	Industrial Relations Personnel Department Personnel and Labor Relations
Public Works	Plant Maintenance and Engineering Plant Facilities & Drydocks Plant Engineering Manufacturing Engineering Yard Maintenance and Repair

(continued on next page)

[1]Planning functions are within the Administrative Departments of some private shipyards.

[2]Purchasing and material control functions were found to be within the Finance and Accounting area in some private shipyards and material control within the Production Department of some private shipyards.

Source: Responses from private shipyards to an IDA questionnaire.

Figure 12. COMPARISON OF THE TITLES OF DEPARTMENTS AND OFFICES PERFORMING COMPARABLE FUNCTIONS IN NAVAL AND PRIVATE SHIPYARDS

Naval Shipyards	Private Shipyards
Administrative Department[3]	Plant Protection and Safety Plant Security Police and Fire Industrial Relations[4] Administrative Assistant Finance[5]
Shipyard Dispensary	Industrial Relations Function entitled Medical Director, Industrial Health, Yard Doctor, etc.
Dental Department	No comparable department
Quality Assurance Office	Quality Assurance[6] Quality Control Quality Control and Inspection
Data Processing Office	Finance or variants of Computer Services
Management Engineering Office	No comparable office[7]
Combat Systems Office	Combat systems functions are provided by the SUPSHIPS
Nuclear Engineering Department	Nuclear Power (applicable only to nuclear qualified shipyards)
Radiological Control Office	Radiological Control (applicable only to nuclear qualified shipyards)

[3]Many functions performed by the Administrative Department of a Naval Shipyard, e.g., Chaplain, Military Clubs and Messes, Exchanges and Commissary, have no counterpart in a private shipyard.

[4]The security and fire protection functions in many private shipyards are placed under Industrial Relations or the equipment department. These functions may appear in other departments or as separate offices.

[5]Office administration, communications, and other administrative functions appear within the Finance Department of some private shipyards.

[6]Quality assurance is not identified as a separate department or office in many private shipyards. The functions of quality assurance are assigned to production department supervisors in some private shipyards.

[7]Industrial management and appraisal functions are performed by private shipyard managers in consultation with their senior subordinates. Many of the other functions of the management engineer are not performed by private shipyards.

Figure 12. (continued)

Naval shipyards performing nuclear repair work have two major additions to their organizations: a Nuclear Engineering Department and a Radiological Control Office. Other offices and departments have some additional personnel, such as department nuclear managers and their subordinates, who concern themselves with that department's support of nuclear work. (Refer to Appendix E for identification of these positions.) Private shipyards performing nuclear work also have to perform radiological control and nuclear engineering functions as well as other nuclear-unique tasks. The organizational structures used by private shipyards to provide for accomplishment of these tasks were not determined in this study.

B. FACILITIES

This discussion of naval and private shipyard facilities covers physical assets such as docks, ways, buildings, equipment and open space for storage, assembly, or other use. The facilities that make up the plant proper vary greatly among shipyards. All naval shipyards are large installations with comprehensive facility and equipment capabilities. Private shipyards, however, vary from yards with the full range of equipment and facilities found in naval shipyards to very small yards with a very limited capability to perform ship work.

Naval shipyard facilities are basically requirements-driven. As new ships and more complex weapons systems enter the fleet, facilities to overhaul and repair them must be made available. The Navy justifies the need for these facilities to OSD, OMB, and the Congress. Private shipyard facilities are predicated upon obtaining a return on investment since owners of private yards are profit-motivated. If a profit can be made through investing in new facilities or modernizing existing facilities to obtain work or to fulfill a contract, then such an investment is likely to be made. Examples of such investment are procurement of automated labor-saving

machines, construction of larger shipbuilding ways and basins, construction of new erection slabs, and construction of modern shop facilities

1. Facilities in Naval Shipyards

The naval shipyards are among the most modern and well-equipped yards in the United States, yet some drydocks, buildings, and utilities date back to 1900 or earlier. The Naval Shipyard Modernization Program, which has been under way for about ten years, has been the vehicle for funding improvements in buildings, docks, piers, and equipment.[1] Naval shipyards possess a wide range of industrial plant equipment to accomplish repairs to the fleet. In some instances, these yards possess equipment or facility capabilities not available in the private sector.

Under the aegis of the Shipyard Modernization Program, naval shipyards are modernizing their facilities and equipment.[2] New construction has included buildings that house management

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[1]The Shipyard Modernization Program was started in FY 1965 with shipyard improvements that could be most immediately used, i.e., industrial production equipment and selected facilities improvements to meet workload demands. This first phase ended in FY 1969. Concurrently an industrial engineering study of each naval shipyard was made and a long-range modernization program was developed to upgrade industrial efficiency; balance capacity of the new principal shops; meet workload commitments; and acquire new capabilities or upgrade existing capabilities needed to service new ships and weapons systems. The Shipyard Modernization Program is the only capital investment program through which major industrial facilities and equipment are acquired. This program is principally funded from two appropriations: the Military Construction (MCON) appropriation funds the construction or alteration of major facilities, and the Other Procurement, Navy (OPN) appropriation funds the procurement of industrial equipment and tools.

[2]Although about $400 million has been invested in naval shipyards through the modernization program, only about one-third of the facility and one-half of the equipment objectives have been achieved. These objectives are being reexamined with on-site engineering studies at each naval shipyard. The earliest impact on the budget from these surveys and the restructured program could be in FY 1976 for industrial plant equipment and FY 1977 for military construction.

and engineering functions, shops, utilities, and pollution abatement systems. Other construction has refurbished some graving docks and increased the length and depth of others. The Navy considers the shortage of drydocks as its most urgent problem in modernizing the naval shipyards. Of thirty-five graving docks in commission in the eight naval shipyards, only thirty are sufficiently deep to accomplish the present and immediate future workloads. The other five drydocks are deep enough only for repair of barges, harbor tugs, and other small craft.

Since World War II, ships of the same type have been increasing in size: length, width (beam), draft, and tonnage. Table 6 shows the increase in size of selected classes of ships. Size increases have also occurred in types of ships other than those listed in Table 6. The number of ships in the fleet has declined almost 50 percent from the 1968 peak, yet since 1969, funding for ship depot repair in constant FY 1974 dollars has been relatively stable. Figure 13 depicts the relationship of fleet size and funding for ship depot repair. The number of ships in the fleet on 30 June 1975 represented 51 percent of the total ships in the fleet in 1968, yet, the tonnage of today's fleet is about three-quarters of the 1968 peak.

The need for deeper drydocks is the result of larger ships with deeper drafts plus bow-mounted sonars. Sonar domes are mounted below the keel and usually at the bow on surface escort ships, such as destroyers and frigates; this necessitates high blocking so the dome will clear the drydock floor.

The DD-963 class destroyers illustrate the need for larger and deeper drydocks. These destroyers are 563 feet in overall length, 55 feet in beam, and 20 feet in draft. The combination of the bow-mounted sonar and the extension of the propellers below the keel precludes bringing these ships straight-in over the blocks, thus an offset method of docking must be used. This method requires a drydock 650 feet in length and 124

Table 6. PROGRESSION OF INCREASING SIZE OF SHIPS OVER TIME

Year Comm'd	Category	Tonnage* (Tons)	Length Overall (Feet)	Beam (Feet)	Draft (Feet)
	Aircraft Carriers				
1944	Hancock	44,700	895	103	31
1945	Midway	64,000	979	121	35
1955	Forrestal	78,000	1,039	130	37
1961	Kitty Hawk	80,000	1,063	130	36
1974	Nimitz	91,400	1,092	134	37
	Frigates				
1960	DLG-6	5,800	513	53	25
1962	DLG-16	7,800	533	55	25
1964	DLG-26	7,930	547	55	29
1974	DLGN-36	10,150	596	61	32
	Destroyers				
1943	Fletcher	3,050	377	40	18
1945	Gearing	3,500	391	41	19
1955	DD-931	4,050	418	45	20
1974	DD-963	7,800	563	55	29

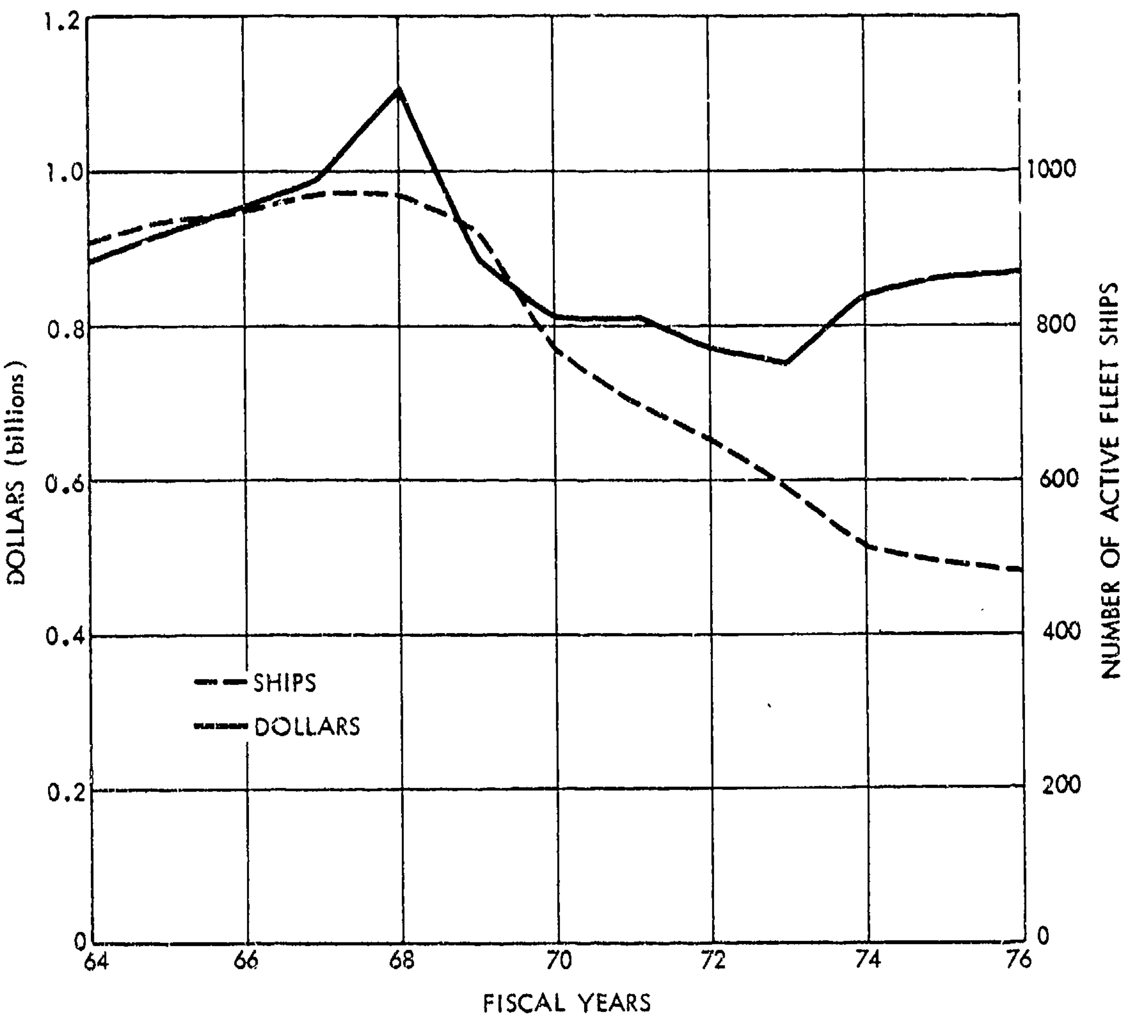
Note: All dimensions in feet were rounded to the nearest whole number.

*Tonnage displayed is full load displacement.

Source: *Janes Fighting Ships*, 1974.

feet-8 inches in width, with 40 feet of water over the drydock floor. The bow-mounted sonar dome also requires 12-foot keel blocks to provide sufficient clearance between the sonar dome and the floor of the drydock. (Details of the docking of the DD-963 class ships are found in Appendix G.)

In addition to increases in the physical size of Navy ships, there have been significant increases in their complexity. For example, guided missile ships have replaced less complex destroyers, and nuclear submarines have replaced diesel submarines. The percentage of the fleet made up of nuclear-powered ships has increased from about 4 to 21 percent over the last twelve years.



Source: ASD (PA&E) Logistics Division and the Summary of Naval Approved Program published by the Director, Department of Navy Program Information Center.

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Figure 13. COMPARISON BY YEAR OF THE NUMBER OF SHIPS IN THE FLEET WITH TOTAL SHIP DEPOT REPAIR COSTS (CONSTANT FY1974 DOLLARS)

The combination of increasing ship size and complexity has increased demands on naval shipyard facilities. To meet fleet demands for modernization and to maintain a satisfactory material condition, naval shipyards must possess the necessary facilities. This requirement is even more critical since currently only a few private shipyards possess the facilities to repair complex combatant ships (see Table 3).

a. Non-Nuclear Repair

Repair is a job-shop operation. In the context of this discussion, it includes the correction of inoperative or malfunctioning equipment and machinery; the overhaul of equipment; preventive maintenance work on machinery that, while still operative, gives indications of possible malfunctioning in the near future; and the alteration or modification of equipment, machinery, and other fixtures and appurtenances of a Navy ship. Repair can be accomplished in a variety of ways. Some equipment and machinery are repaired in-place; others are dismantled, removed from the ship, and sent to the appropriate shop. Removal of large pieces of equipment and machinery from the ship frequently involves cutting access openings in the hull. On ships such as submarines, the cutting of access openings is done only while the ship is in drydock. Drydocking of a ship is required during the regular overhaul of Navy ships in order to accomplish repairs to the underwater body of the ship.

Alterations may vary from a minor change in a piece of equipment to major changes to structures, such as deck houses and compartments, and systems. The latter work may entail the complete removal of all equipment in a compartment and the installation of new equipment and fixtures.

Performing what appears to be the same work on two ships of the same class may in fact be two quite different jobs. For example, prior to the procurement of amphibious assault

ships and the DD-963 class destroyers from a single shipbuilder, ships of the same class were built by several contractors. These contractors, although following essentially the same set of plans, performed operations differently and used different suppliers to obtain equipment, machinery, and related components. As a result, ships of the same class may possess the same outward appearance and general arrangement, but they differ in equipment. (This is especially true for valves, pumps and motors. Not only are many different types used but they are installed in many different ways on the ships.) This condition is much more prevalent in surface ships than in submarines because there were fewer submarine builders and tighter configuration control has been exercised by the Navy on submarines.

The facilities required to repair a Navy ship are complex and include a wide range of capabilities. This discussion will treat regular overhaul, which together with conversion, places the greatest demand on the shipyard for facilities. The first basic requirement is for a drydock. Drydocks in the naval shipyards basically are graving docks, augmented in some yards by floating drydocks and marine railways.[1] While the ship is in drydock the underwater body is blasted to strip the old protective coatings down to bare metal and then new preservative coatings are applied. In addition, devices to reduce or prevent corrosion are repaired or replaced. Propellers, rudders, shafts, sonar domes, and sea valves also are repaired during drydocking. Special equipment used in the drydock during these repairs are automated side-blasting machines or other blasting machines, self-propelled man lifts, and propeller, shaft, and rudder-handling equipment. The drydocking period varies from a few weeks to many months depending upon the type

[1]The following naval shipyards have floating drydocks: Charleston (1) and Long Beach (2). There are two marine railways at Philadelphia and at Pearl Harbor.

of ship and the nature of the work to be accomplished by the various shops in the shipyard.

Naval shipyard shops are categorized into four groups: structural, mechanical, electrical, and service.[1] A number of shops are included in each of the four groups:

STRUCTURAL GROUP:	Shipfitting, Sheetmetal, Welding, Boiler and Forge Shops
MECHANICAL GROUP:	Central Tool, Inside Machine, Marine Machine, Pipe, and Pattern Shops, and the Foundry
ELECTRICAL GROUP:	Electrical and Electronic Shops
SERVICE GROUP:	Woodworking, Rigging and Laborer Services, and Temporary Services Shops

Appendix H contains a list of typical industrial plant equipment in each shop in each of the four groups and a description of the responsibilities, functions, and operations of the shops.

Facilities and industrial plant equipment identified with each shop are not always in one central building or location. In some naval shipyards, particular shop facilities and equipment are centralized, but in others a shop may have equipment located in a number of separate buildings. This distribution has resulted from expansion of functions of some shops without a corresponding increase in plant space and from the establishment of satellite shop facilities to promote more efficient use of tools and reduce personnel movement within a shipyard. In one naval shipyard, for example, the Central Tool Shop had assigned space in nine different buildings.

The facilities and industrial plant equipment involved in overhaul or repair work vary according to the nature of the repairs and alterations. The mechanical and electrical shops generally are utilized extensively in most overhauls. The

[1]A shop may refer to the designation of a certain trade, e.g., welding and shipfitting, or to the building or physical facilities in which the industrial plant equipment used by a trade is located.

structural shops and pipe shop become heavily loaded during conversion work and alteration of piping and tanks to meet environmental standards.

In addition to the general types of facilities and equipment discussed above, some naval shipyards have unique industrial plant equipment and drydocks of certain sizes to support specific capabilities assigned by the CNO. These CNO assignments are summarized in Figure 14 and Table 7. Table 8 identifies the unique facilities and some of the major items of industrial plant equipment located at naval shipyards. This table provides the reader a capsule view of the types of industrial plant equipment and facilities possessed by each naval shipyard.

- Two shipyards on each coast capable of repairing aircraft carriers
- One shipyard on each coast capable of repairing surface nuclear ships
- Three shipyards on each coast capable of overhauling nuclear submarines
- Three shipyards on each coast capable of installing, maintaining and checking out sophisticated electronics and missile weapon systems
- Shipyards to serve major homeport and operating areas

Source: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974,* 93rd Cong., 2nd sess., July-October 1974, Part I, p. 192.

Figure 14. THE NAVY'S STRATEGIC AND OPERATIONAL REQUIREMENTS FOR NAVAL SHIPYARDS

Table 7. U.S. NAVAL SHIPYARD STRATEGIC CAPABILITIES ASSIGNMENT

Strategic Capabilities Assignment	Atlantic Coast Shipyards				Pacific Coast Shipyards			
	Portsmouth	Philadelphia	Norfolk	Charleston	Long Beach	Mare Island	Puget Sound	Pearl Harbor
Aircraft Carriers		X	X		X		X	
Guided Missile		X	X	X	X		X	X
Anti Submarine Ship		X	X	X	X		X	X
Nuclear Attack Submarines	X		X	X		X	X	X
Polaris and Poseidon Submarines	X			X		X	X	
Diesel Submarines		X				X		
Surface Nuclear Overhaul			X*			X	X	
Strategic Location								X

*Limited capability.

Source: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., Part I, July-October 1974, p. 193.

Table 8. MAJOR FACILITIES AND EQUIPMENT LOCATED IN NAVAL SHIPYARDS

Facilities and Equipment	Portsmouth	Philadelphia	Norfolk	Charleston	Long Beach	Mare Island	Puget Soun'	Pearl Harbor
Automated steel handling facilities including:								
automated steel field gantry crane	--	X	--	--	--	--	--	--
automated plate cleaning and preservation facility	--	X	X[1]	--	X	--	X	--
automated collocator car	--	X	--	--	--	--	--	--
Overhead bridge crane with magnetic or vacuum lift	X	X	X	X	X	X	X	X
Numeric and optical controlled cutting machines	--	X	--	--	--	X	X	--
Overhead monorail material handling system	--	--	--	--	--	X	X	--
Driverless train	--	X	--	--	--	X	X	--
Stockraster sheet metal handling device	--	--	--	--	--	X	X	--
Large crawler-equipped "ringer" crane	--	--	--	--	--	--	X	--
Floating crane (tons)	90	90	150	100	350[2]	90	100	125
Self-propelled man lift	--	X	--	X	X	X	--	X
Automated side blasting machine	--	--	X	--	X	--	--	--
Propeller, shaft and rudder handling equipment	X	X	X	X	X	X	X	X
Numerical controlled boiler tube bending machine	--	--	--	--	X	--	--	--
Numerical controlled turret punch	X	X	X	--	X	X	X	X
Numerical controlled vertical turret lathe	X	X	X	X	X	X	X	X
Numerical controlled drilling machine	X	X	X	X	X	X	X	X
Numerical controlled machining center, 5 axis	X	--	--	--	--	X	--	--
Numerical controlled machining center, 4 axis	--	--	--	--	--	X	X	X
Numerical controlled propeller profiler	--	X	--	--	--	--	--	--
Numerical controlled ball turning machine	X	--	--	--	--	--	--	--
Tape preparation capability	X	X	X	X	X	X	X	X
Plate planer	X	X	X	X	X	X	X	X

(continued)

[1]Plate blast only.

[2]Self-propelled.

Table 8. (continued)

Facilities and Equipment	Portsmouth	Philadelphia	Norfolk	Charleston	Long Beach	Mare Island	Puget Sound	Pearl Harbor
Large shafting lathe	110"x61'	60"x75'	60"x75'	48"x70'	69"x75'	48"x85'	42"x150'	48"x51'
Plate bending roll	1"x32'	1"x36'	1-1/2"x36'	1"x36'	5/8"x10'	4-1/2"x16'	1-1/2"x36'	1-1/2"x30'
Angle or frame bending roll	X	X	X	X	X	X	X	X
Forging press or hammer (tons)	2	800	2000	500	500	2000	2000	1000
Heavy press brake (tons)	X	X	X	X	X	500/750	X	X
Propeller balancing facility (tons)	10	50	25	50	50	50	45	50
Diesel engine analyzer	--	--	--	--	X	--	--	--
Pump test facility	--	--	--	--	X	--	X	--
Open side planer	3'x5'	--	6'x20'	12' long	5'x5'	3-1/2'x16'	3'x12'	--
Shear	12'x1"	10'x1"	12'x1"	10'x1-1/4"	12'x1-1'4"	8'x1"	8'x1-1/2"	9-1/2'x1"
Automatic abrasive blasting facility	X	--	X	X	X	X	--	--
Acoustic measurement facility	X	--	--	X	--	--	X	--
Shipboard electronic systems evaluation facility	--	--	X	X	X	X	X	X
Nuclear refueling facility	X	--	X	X	--	X	X	X
Nuclear production shop	X	--	X	X	--	X	X	X
Radiography facility	X	X	X	X	X	X	X	X
Ultrasonic testing facility	X	X	X	X	X	X	X	X
Mechanical/optical standards laboratory	X	X	X	X	X	X	X	X
Antenna boresight and calibration range	--	--	X	--	--	--	--	--
Numerical controlled machining center, 3 axis	X	X	X	X	X	X	X	X
Tape verification system (drum plotter)	--	--	--	--	--	X	--	--
Sheetmetal shear to length system	--	--	--	--	X	--	--	--

Source: Navy Officials from the NAVSEA Facilities and Equipment Division.

b. Nuclear Repair

This discussion covers nuclear refueling and repairs to the reactor plant and associated systems. The interface between what is nuclear and non-nuclear in a system is usually identified at a designated valve where the system piping passes from one compartment to another. Repair in the non-nuclear areas of a nuclear-powered ship is conducted in the same manner as on a similar non-nuclear ship. To facilitate work on nuclear components, separate nuclear repair facilities are located adjacent to the drydock in which the nuclear-powered ship is docked. These facilities are identified as a Nuclear Production Shop and a Nuclear Repair/Refueling Facility.

The Nuclear Production Shop employs various trades and includes a small machine shop for work on non-contaminated nuclear components. Nuclear components that require use of machines not available in the Nuclear Production Shop are sent to the appropriate machine shop in the shipyard. In some instances, this process requires special handling and isolating.

In the Nuclear Repair/Refueling Facility, located in a building adjacent to the drydock, nuclear refueling is conducted and repair work on contaminated nuclear components is performed. The facility includes various machines tools, decontamination equipment, and a radioactive waste-water processor. Access to the reactor section of the ship may be gained from this facility through a tunnel to the drydock floor and then via a temporary enclosure to the ship. This facility provides the location for personnel to don special clothing, which must be worn when working with contaminated material, and for personnel decontamination. Personnel working in areas of potential radiation must wear devices that record any radiation received. The amount of radiation received by personnel is monitored frequently to avoid having an individual exceed the allowable limit.

Not all naval shipyards licensed to perform nuclear refuelings or repair work have a permanent facility from which to perform these functions. Temporary facilities in the form of barges or other enclosures must be used to provide the equivalent physical facilities of the Nuclear Repair/Refueling Facility.

Special requirements or criteria must be satisfied before equipment can be certified for the handling of nuclear materials. For example, cranes must meet separate, more rigid criteria and possess a fail-safe braking system prior to certification for use in lifting nuclear material.

Nuclear repair work can be characterized as start-and-stop work. This is due in part to requirements for complete and thorough quality assurance. The individual who performs the work cannot inspect it or certify that it meets the required specifications. Thus, a second person is involved in all quality assurance inspections. When a mechanic or technician performs an operation as part of a total job, he may not proceed further until the operation just completed passes the quality assurance inspection or test. These comprehensive step-by-step inspection and test operations are not normally performed in non-nuclear repair work.

c. New Construction

New construction in naval shipyards would be accomplished through the use of essentially the same facilities and industrial plant equipment that are used in repair work, but in different industrial combinations. These facilities and equipment will be discussed below.

Four naval shipyards, Portsmouth, Philadelphia, Mare Island, and Puget Sound, are considered by the Navy to possess a new construction capability.

Table 9 displays the building positions of the four naval yards. Two naval shipyards (Portsmouth and Mare Island) have building ways on which ships can be constructed. Both of these shipyards have been submarine building yards in the past. The four shipbuilding ways at Portsmouth are contained inside a building, thus the size of ship that can be constructed is constrained by the ways and the building parameters.

Table 9. SHIPBUILDING POSITIONS IN THE FOUR NAVAL SHIPYARDS WITH NEW CONSTRUCTION FACILITIES

Shipyard	Drydocks for Shipbuilding			Building Ways	
	Length	Clear Width	Depth Over the Sill	Overall Length	Width
Portsmouth				(2) 435	55
				(2) 400	55
Philadelphia	1,093	143	40		
	1,093	143	43		
Mare Island*				680	105
				455	89
Puget Sound	927	111	24		
	998	134	45		
	1,031	134	45		

*At Mare Island there are two double building ways capable of supporting the construction of four nuclear or ballistic missile submarines.

Source: The Departments of Defense and Commerce, "Principal Shipbuilding and Repair Facilities of the United States," Washington, D.C., April 1973.

In a written response to IDA questions concerning what additional facilities and equipment were needed to build SSN-688 class submarines, NAVSEA listed the following as required capital improvements at Portsmouth: (1) additional power for testing, $1.2 million, and (2) dredging at ways and pier, $2.0 million. Additional facilities that might be desirable to improve efficiency were (1) a 128-ton, special-purpose lift capacity, $1.5 million, (2) increase in the capacity of the test boiler, $1.5 million, and (3) an expanded electric feeder capacity from a public service company, $1.6 million.[1]

Mare Island Naval Shipyard has two double building ways capable of accommodating simultaneously, construction of four SSNs or SSBNs. Surface ships up to the size of a DLGN could be constructed on the ways.[2] The ways are outfitted with special utilities, heat-shielding and weight-handling equipment up to 60 tons. The weight-handling capacity can be augmented by the use of floating cranes.

Mr. Wilbur N. Ginn, Jr., during NAVSEA testimony before the House Seapower Subcommittee in July 1974, indicated that "Mare Island still has the potential capability to undertake a limited shipbuilding program utilizing existing facilities."[3] Mr. Ginn went on to say that if long-term submarine shipbuilding were assigned to Mare Island, a new shipbuilding complex could be developed for efficient and economical production:

> This new construction complex would consist of integrated building ways, structural shop, and automated steel storage yard. These facilities would incorporate the latest concepts in automated plate storage, handling, blasting, and painting in the steel storage yard;

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[1]NAVSEA Letter 0712: JPM, serial 415 of 23 April 1975, which is attached to this report as Appendix I.

[2]DLGN-38 class frigates are 585 feet in length, 61 feet in beam, and have a draft of 30 feet in full load displacement.

[3]U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part I, p.490.

numerical lofting and numerically controlled flame cutting in the structural shop, and integrated straight-line-flow processing of hull sections with required weight-handling, radiographic inspection, and special utilities and support services.[1]

In its response to the previously mentioned IDA questions, NAVSEA identified three areas as required capital improvements at Mare Island for new construction: (1) increased weight-handling capacity over the ways, $1.5 million, (2) up-graded electrical power supply on the building ways, $0.2 million, and (3) additional power at the fitting-out berth, $0.5 million. In addition, the following improvements were identified as desirable to increase efficiency at Mare Island: (1) rearrange the plate yard, $3.7 million, (2) extension of the structural shop, $7.5 million, and (3) new enclosed building ways, $21.0 million.

The other two naval shipyards that have a new construction capability (Philadelphia and Puget Sound) could build ships in graving docks. The Philadelphia Naval Shipyard could construct ships in two drydocks adjacent to an area containing assembly slabs, an automated steel yard, a structural fabrication and assembly building, and material-laydown areas.[2] These facilities, which were designed primarily to support new construction, are inactive except for occasional use of one of the drydocks.

Puget Sound Naval Shipyard could construct ships in the three drydocks that were used in times past for new construction. Of these, drydock number 3, though the smallest, is a logical choice for new construction since its utility for repair of ships is limited by water over the blocks (19 feet). Also drydock number 3 is adjacent to the structural shop, where

[1]Estimated costs for these improvements were not presented.

[2]Each of the two drydocks is 143 feet wide and 1,093 feet long, with a minimum of 40 feet of water over the sill.

large subassemblies can be prefabricated. The structural shop has a floor area of 400,000 square feet, of which about one-half is currently used to support repair work. The other two drydocks are somewhat larger and have been used in the recent past to construct fast combat support ships. These drydocks are currently used extensively for ship repair. Placing new construction in these drydocks would significantly reduce the shipyard's total repair capacity.

New construction is a process in which material-flow controls the pace of the work. In other words, the limiting factor is the amount of steel (in tons-per-day) that can be processed. New construction involves a hull-erection process and installation of machinery, equipment, associated components, and various fittings into the ship. The installation or outfitting may follow the erection of the hull or the hull may be constructed in sections and the installation or outfitting accomplished somewhat concurrently. This latter process is referred to as pre-outfitting.

New construction is characterized as a sequential industrial process. Especially in the early stage of construction, each labor trade group tends to perform its work following the completion of the work of another trade group. Initially, for example, most of the work is performed by shipfitters and welders in erecting the hull. Near the end of the hull-erection, pipefitters and sheetmetal workers install piping and ducting. As the ship nears completion, more of the trade groups work simultaneously on the ship.

As mentioned earlier, some facilities in the naval shipyards would be used exclusively or most frequently for new construction. The shipbuilding ways and their locations have already been mentioned. The steel handling and processing facilities comprise the largest segment of facilities used solely in new construction. Figure 15 is a display of the

facilities and equipment in naval shipyards specifically oriented to new construction.

- Building ways and Building Basins
- Automated steel yards and plate handling systems, such as collocator car, steel field gantry crane, overhead bridge cranes with electro-magnetic or vacuum lifts
- Automated steel plate blasting and painting machines
- Numeric and optically controlled flame cutting machines
- Automated plate lines
- Automated panel lines
- Subassembly areas
- Assembly slabs or platens
- Frame bending rolls
- Plate bending rolls
- Heavy forging hammers
- Certain foundry facilities
- Heavy presses

Figure 15. NEW CONSTRUCTION ORIENTED FACILITIES AND EQUIPMENT

2. Facilities in Private Shipyards

The spectrum of facilities and equipment found in private shipyards is very broad because of the diverse nature of the work performed. Establishments range from small boat shops to repair yards, with or without drydock facilities, to complete shipyards comparable to naval shipyards. Other shops or firms specialize in different categories of repair, such as diesel engines, marine electrical and machine work, cargo booms and rigging, and painting. Private shipyards and repair firms are categorized by MARAD according to their capability to perform as major shipbuilding and repair facilities and as facilities available for performing topside repairs.[1]

The Maritime Administration has categorized twenty-five private shipyards as shipbuilding yards, thirty-seven as repair yards with drydock facilities, and fifty-nine as facilities available for performing topside repairs on ships 300 feet in length or more.[2] These totals do not represent a complete list

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[1]Department of Commerce, Maritime Administration, Division of Production, Office of Ship Construction, *Report on Survey of U.S. Shipbuilding and Repair Industry-1973*, Washington, D.C., 1974. The facility categories are defined by the Maritime Administration as follows:

Major Shipyard is one that has at least one building position (either an inclined way, side launching platform, or a building basin) capable of accommodating a maximum ship size of 475 feet length-over-all (LOA) and a beam of 68 feet. These dimensions represent the smallest size ship that would be mass produced for mobilization purposes.

Major drydocking facilities are those engaged primarily in repair or reconstruction and having at least one drydock that can accommodate ships 300 feet or more in length. These yards do not usually engage in new construction, but the possibility exists if the situation demands it.

Major topside repair facilities are those having the capability to provide repair service to ocean-going ships (generally 300 feet in length or over) when the work can be accomplished without taking the ships out of the water. Many of these facilities lease pier space on a job basis or they send personnel and equipment to the ship.

[2]This category does not include the General Dynamics Corporation, Electric Boat Division, Groton, Connecticut, which is dedicated to Navy work.

of all shipyards that fall into one of these categories. The totals are based upon an annual survey sent to private shipyards by MARAD, but not all private shipyards responded.[1]

As indicated earlier, one way of ranking the private shipyards by size is according to their mobilization employment potential. This value is used as an indicator of shipyard size since all shipyards are facilities-constrained at some level of employment, if additional investment is not made. Examination of the mobilization employment potential of the shipyards categorized as shipbuilding and repair yards reveals that, in general, the shipyards capable of new construction have the greatest mobilization employment potential, and hence, are larger shipyards. Seventy-five percent of the private shipyards with a mobilization employment potential of 5,000 or more are categorized as new construction yards. Table 10 shows the number of private shipyards categorized as shipbuilding yards and repair yards with drydock facilities on the basis of mobilization employment potential. Mobilization emeployment potentials were not given for fifty-nine private shipyards categorized as capable of topside repair on ships 300 feet or more in length.

Two publications provide basic information about major shipbuilding and repair facilities--MARAD's annual *Report on Survey of U.S. Shipbuilding and Repair Industry*, cited earlier, and the *Principal Shipbuilding and Repair Facilities of the United States* prepared by the Office of the Coordinator for Ship Repair and Conversion.[2] This latter document is periodically published and updated.

As discussed in Section A.3, a basic source of information about the facilities in private shipyards is Standard Form 17,

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[1]Discussions with Maritime Administration officials.

[2]Department of Defense and Department of Commerce, Office of the Coordinator for Ship Repair and Conversion, Washington, D.C., April 1973.

Table 10. PRIVATE SHIPYARDS CATEGORIZED AS NEW CONSTRUCTION OR REPAIR ACCORDING TO MOBILIZATION EMPLOYMENT POTENTIAL

Mobilization Employment Potential	New Construction	Repair
10,000 or more	9	0
5,000 to 10,000	6	5
less than 5,000	6	28*
Not available	4	4
Total	25	37

*Eight shipyards had a mobilization employment potential falling between 2,500 and 5,000 employees.

Source: U.S. Department of Commerce, Maritime Administration, Division of Production, Office of Ship Construction, *Report on Survey of U.S. Shipbuilding and Repair Industry-1973*, Washington, D.C., 1974.

"Facilities Available for the Construction or Repair of Ships," which MARAD mails annually to about 160 private shipyards and repair facilities. Data were extracted from Standard Forms 17 submitted by seventy-one private shipyards to provide an indication of the facilities found in the private sector. The private shipyards were ranked according to mobilization employment in each of three categories--shops, major equipment, and work subcontracted.

Table 11 shows the shops listed on Standard Form 17 and the percentage of private shipyards reporting those shops as part of their shipyards. The absolute percentages fluctuate, but as expected, the trend is for the larger shipyards to have a broader spectrum of shops. Shipyards with a maximum employment potential of 5,000 or more employees have essentially the same types of shops. This is consistent with the previous notation that seventy-five percent of the shipyards

Table 11. PERCENTAGE OF PRIVATE SHIPYARDS, BY SIZE OF SHIPYARD, WITH VARIOUS TYPES OF SHOPS

(Measured in terms of mobilization employment potential)

	Mobilization Employment Potential						
Shops[1]	<500	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-19,999	20,000 or more
Fabrication	100	93	100	62	91	100	100
Plate	22	36	73	62	55	57	50
Sheetmetal	56	36	91	85	73	100	100
Subassembly	33	21	45	23	55	86	17
Carpenter	89	64	100	69	91	71	83
Woodworking[2]	22	14	45	23	45	43	33
Boat assembly or molding	22	36	18	54	36	29	33
Machine[3]	100	79	100	85	100	100	100
Electrical[4]	89	64	73	100	91	86	100
Electronic	11	21	27	23	18	43	50
Pipe	78	57	100	92	91	100	100
Galvanizing	--	--	--	15	9	29	--
Foundry	--	7	--	15	27	29	50
Rigger	67	21	91	62	73	86	67

[1]The titles of the shops are as designated in Standard Form 17, "Facilities Available for the Construction or Repair of Ships," which is mailed by the Maritime Administartion each year to about 160 shipyards and repair facilities. Other shops reported by some private shipyards are boiler, abrasive blast, paint, forge, copper, blacksmith, diesel engine, valve, and aluminum fabrication.

[2]Reported by some private shipyards as joiner shop.

[3]Includes all types of machine shops, inside and outside.

[4]Electronic shop combined with electrical shop in some private shipyards.

Source: Standard Forms 17, "Facilities Available for the Construction or Repair of Ships," on file with the Maritime Administration.

with a mobilization potential of 5,000 or more employees are categorized as capable of new construction. What the percentages do not reveal is the size, complexity, or number of these shops. Some private shipyards reported as many as four shops of the same type.

Table 12 lists the major equipment in private shipyards, as reported on Standard Form 17. Again, the percentages fluctuate, but an examination of the types of equipment used in new construction shows that, as expected, such equipment as flame cutting machines, furnaces, planers, bending rolls, shapers, and shears are reported more frequently by the larger shipyards. Larger shipyards use these types of equipment primarily during new construction. These larger shipyards also have more sizes and applications of certain types of equipment, e.g., lathes, presses, and boring mills.

Table 13 shows the categories of work most often subcontracted by private shipyards. The percentages vary, but they indicate that the larger private shipyards do subcontracting in fewer areas of work than do the smaller private shipyards. In addition to size of the private shipyard, the availability of certain skills or dependable subcontractors appear to be influencing factors as to the amount of subcontracting undertaken.

Three factors influence the percentages in Tables 11, 12, and 13. First is the number of private shipyards in each size category. They vary from six to fourteen. At the low end of the sample size range, one shipyard represents 16 percent of the sample and at the other end of the range one shipyard represents only 7 percent of the sample column. Second, there was wide variation in the completeness of the information submitted on the Standard Forms 17. From an examination of the reports, it was obvious that some private shipyards took the time to complete the forms in exacting detail while others completed them perfunctorily, omitting some of the requested information. Third, a considerable

Table 12. PERCENTAGE OF PRIVATE SHIPYARDS, BY SIZE OF SHIPYARD, WITH VARIOUS TYPES OF MAJOR EQUIPMENT

(Measured in terms of mobilization employment potential)

	Mobilization Employment Potential						
Major Equipment*	<500	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-19,999	20,000 or more
Hydraulic pipe bender	22	21	45	31	36	29	--
Bending brake or press	22	57	18	38	64	29	67
Flame cutting machine	22	21	18	8	36	57	50
Radial drill press	33	50	33	31	36	43	50
Furnace(s), angle, box or plate	11	7	44	54	73	86	83
Engine lathe	33	29	18	54	45	29	67
Miscellaneous lathes	56	64	64	54	73	57	50
Balancing machine	--	--	18	8	9	14	50
Milling machine	22	50	64	23	9	29	17
Vertical boring mill	44	50	64	69	82	57	83
Horizontal boring mill	22	57	18	54	55	29	17
Planers, flame, open-side or plate	22	43	36	69	45	71	83
Hydraulic presses	22	64	55	92	64	43	50
Bending rolls	44	57	82	92	91	71	100
Shapers	--	29	18	15	--	14	33
Shears	22	43	64	46	55	71	100

*Other equipments reported by some private shipyards are forges, plate blast machines, X-ray machines, punches, core ovens, T-beam welder and vacu-plate lift.

Source: Standard Forms 17, "Facilities Available for the Construction or Repair of Ships," on file with the Maritime Administration.

Table 13. PERCENTAGE OF PRIVATE SHIPYARDS, BY SIZE OF SHIPYARD, SUBCONTRACTING FOR VARIOUS CATEGORIES OF WORK

(Measured in terms of mobilization employment potential)

Areas Subcontracted[1]	Mobilization Employment Potential						
	<500	500-999	1,000-2,499	2,500-4,999	5,000-9,999	10,000-19,999	20,000 or more
Boiler brickwork	33	29	18	38	27	--	33
Flooring and deck coverings	22	7	36	54	55	43	67
Electrical[2]	33	29	45	23	18	--	--
Electronic	56	50	36	38	18	--	33
Instrument work	--	--	27	23	18	--	--
Ordnance	22	14	9	15	--	--	--
Air conditioning and refrigeration	33	--	9	31	19	14	33
Insulation and logging	89	29	64	62	55	43	50
Foundry	22	14	9	23	9	14	17
Galvanizing	11	14	--	15	9	29	17
Sheetmetal	33	29	18	8	9	--	--

[1] Other areas reported by some private shipyards are special coatings, X-ray weld inspection, joiner work, plating, and woodworking.

[2] Some private shipyards reported only electric motor rewind as subcontracted in the electrical area.

Source: Standard Forms 17, "Facilities Available for the Construction or Repair of Ships," on file with the Maritime Administration.

difference of opinion was reflected in the entries in the section entitled major items of machine tools and equipment. For example, what one shipyard considered as a major item another shipyard omitted as not appropriate.

From the previous discussion and the accompanying figures, it is clear that private shipyards vary widely in their organic facilities. Complete and comparable detailed data about the facilities at each private shipyard are not readily available because of the voluntary manner in which the information is currently obtained.

a. Non-Nuclear Repair

Navy repair work is predominately placed in private shipyards through the competitive bid process. Private shipyards holding Master Ship Repair Contracts and located within the geographically prescribed bid area are eligible to bid on Navy work. These shipyards, which differ in the facilities they possess to perform Navy shipwork, fall into three groups.

The first group is composed of small yards engaged in small boat or yacht work and other small contractors that specialize in certain types of repairs, such as diesel engines or marine electrical and machine work. They bid only on work packages in their area of specialization or bid with the intention of subcontracting the work for which they do not have a capability. At times, these specialized repair shops act as subcontractors. The work accomplished by these repair shops is either ship-to-shop or the contractor sends his repairmen aboard ship to perform the repairs in-place.

Another group bids only on topside work. This includes all work connected with an overhaul, except the drydocking and underwater body work. These contractors usually have a nucleus of mechanics in the mechanical and electrical trades plus pier space as needed. Most of these contractors can work only on

Navy auxiliary ships because they are constrained both by available facilities and by skilled manpower. This group of contractors also relies heavily on subcontracting.

The private shipyards engaged in repair and having drydocks and shops comprise the last group to be discussed. The sizes and capabilities of the private shipyards within this group vary greatly. In terms of current employment, they range from less than 100 to about 2,000 employees. (Private shipyards engaged primarily in new construction are excluded.) The range of facilities, particularly the shop equipment, is also wide. Floating drydocks are the most common type of drydocks available. The major constraints in this group of shipyards are the level of electrical power available, general skilled labor manning levels, and the number of technically trained personnel and items of equipment required to work on complex Navy weapon systems. The electrical power requirements of many combatant ships exceed the capabilities of a large number of private shipyards, which prevents them from competing for this work. On occasion, this situation has been temporarily alleviated by use of portable power generators.

b. Nuclear Repair

The Navy and the three private shipyards engaged in nuclear repair did not provide any information to IDA relating to nuclear repair. Since all nuclear work for the Navy is controlled by the NAVSEA Nuclear Power Directorate, it can be assumed that nuclear power facilities similar to those found in naval shipyards would be found in the three private shipyards.

c. New Construction

Of the twenty-five private shipyards categorized by MARAD as shipbuilding yards, six were building ships for the Navy

in 1974. Two other small shipyards were building mine-sweepers for a foreign country and tug boats for the Navy. The private shipyards categorized as shipbuilding yards vary in their current employment from about 100 to over 20,000 employees. The range and depth of facilities to perform new construction also vary widely.

Private shipyards build ships on shipways or in building basins. The latter are similar to graving docks, except they are generally shallower and the pumping rate to dewater the dock is slow. These two factors make building basins unsuitable for routine drydocking of ships. Moreover, these basins are usually unavailable because they are being used for ship construction.

The data in Tables 11 through 13 provide a basis for identifying repair and shipbuilding yards. Shipyards having mobilization employment potential of less than 2,500 employees generally are repair yards, those between 2,500 and 10,000 employees represent both repair and shipbuilding, while those with a mobilization employment potential of 10,000 or more employees are shipbuilding yards. Once again for the reasons previously cited, clear distinctions cannot be drawn from the figures, but common characteristics can be noted. For example, the shipbuilding yards have a broader range of shops and equipment than do the yards that perform only repair work and the shipbuilding yards do less subcontracting.

3. Summary of Shipyard Facilities

In comparison with U.S. private shipyards, naval shipyards are large industrial complexes equipped with relatively modern facilities and industrial plant equipment. Only a small number of private shipyards compare favorably with naval shipyards. Repair and modernization work receive top priority in naval shipyards, thus the facilities and equipment are

oriented to repair. New construction requires most of the facilities needed for repair work plus steel plate-processing facilities. Four naval shipyards possess new construction facilities (Portsmouth, Philadelphia, Mare Island, and Puget Sound Naval Shipyards).

In the private sector, MARAD has categorized twenty-five private shipyards as major shipbuilding yards. In 1974, six of these yards were building ships for the U.S. Navy. Some private shipyards prefer to build ships, while others seek ship repair business. Many private shipyards do both types of work in an effort to maintain a stable workload.

Figures 16 and 17 summarize comparisons in facilities with regard to new construction versus repair, and naval shipyards versus private shipyards.

C. MANPOWER[1]

As shown in Table 14, the shipbuilding and repair industry is labor intensive when compared with all operating manufacturing industries. Within the shipbuilding and repair industry, repair is a more labor-intensive activity than shipbuilding. In major shipbuilding yards, many of the operations for plate handling, lofting, flame cutting, and welding of steel plates have been automated thereby reducing the labor required. The use of numerical-controlled machines in shops has reduced somewhat the skilled labor required for repair work; however, over 50 percent of the repairs are accomplished aboard ship, where there is little opportunity for work automation.

Shortage of skilled labor is a problem in both naval and private shipyards, but for a variety of interrelated reasons,

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[1]This section describes manpower skills required in naval and private shipyards and discusses differences in skills required for ship new construction and repair. This parallels the treatment of organizations and facilities and, therefore, is institutional in character. Chapter VI addresses manpower more comprehensively and emphasizes factors affecting its availability.

New Construction	Repair
Large plate storage yard, may be automated	Small plate storage facility
Automated plate cleaning and preservation facility	Cleaned and preserved in the Paint Shop facilities
Automated plate handling equipment	Plate handling by non-automated equipment
Numerical controlled lofting	Manual lofting normally adequate
Numerical controlled flame cutting	Flame cutting performed manually by burners
Numerical controlled welding equipment	Most welding performed manually
Large capacity weight handling equipment	Moderate capacity weight handling equipment is usually adequate
Large structural (shipfitter) shop	Small to moderate size shop adequate, may be combined with Boiler and Forge Shops
Large subassembly slabs or area	Small subassembly slabs or areas
Large laydown area for materials	Moderate laydown area for materials, part of which must be covered to protect material removed from ships.
Building ways or basin--shallow depth	Graving dock or floating dry-dock--deep depth

Figure 16. COMPARISON OF FACILITIES REQUIRED FOR NEW CONSTRUCTION VERSUS REPAIR

Naval Shipyards	Private Shipyards
Graving docks prevalent	Floating drydocks prevalent
Build in graving docks or on building ways*	Build on building ways or in basins
General uniformity as to the type of facilities and shops	Wide variations in facilities and shops
Wide range of capabilities	Except for a few yards, capability range varies
Relatively little subcontracting	Wide variations in subcontracting

*Portsmouth and Mare Island Naval Shipyards have building ways.

Figure 17. COMPARISON OF FACILITY CHARACTERISTICS--NAVAL VERSUS PRIVATE SHIPYARDS

Table 14. COMPARISON OF LABOR INTENSITY IN SHIPBUILDING AND REPAIR AND ALL OPERATING MANUFACTURING INDUSTRIES--1971

Factors As A Percentage Of Value Added	All Operating Manufacturing Industries	Shipbuilding and Repair
	(Percent)	(Percent)
Production Worker Wages	29.7	55.8
Total Payroll	45.9	74.9
Total Labor Cost	52.8	85.2

Source: U.S. Bureau of the Census, *Annual Survey of Manufacturers: 1970-1971*, Washington, D.C.: GPO, 1973.

it appears to be more critical in the private sector. Some reasons may be lower wage rates, poorer fringe benefits, higher turnover rates, lack of large-scale apprentice programs, and the location of yards in or near relatively undesirable areas. Competition from other industries for certain skills also helps cause shortages of skilled labor in the shipyards (e.g., welders, who are used in large numbers in the Contract Construction Industry).

Almost all private shipyards that have attempted to make significant expansions in skilled labor work force to meet increased business have experienced serious difficulties. Extensive recruiting programs have generally failed to produce the needed skilled labor, and unskilled labor has been substituted to attain required manning levels. Training programs have been instituted in an attempt to train workers in sufficient numbers to meet the workload. Most of these efforts have diluted the skilled work force and have resulted in a decrease in productivity.

This section primarily addresses labor skills and the distribution of those skills with respect to the type of work. Other manpower-related areas, such as training, turnover, and shortages of skilled labor, are discussed briefly to provide a general view of the situation. Chapter VI provides a detailed discussion of these areas in addition to other labor-related material.

1. Manpower in Naval Shipyards

Total manpower in the eight naval shipyards comprises naval officers (about 57 per yard), a few Navy enlisted personnel, and about 60,000 civil service employees, of whom roughly 75 percent are wage (blue collar) employees.[1] The graded (white collar) employees are in clerical, management,

[1]Refer to Table 29, p. 217, for a more detailed breakdown.

engineering, and administrative positions. The majority of the wage employees are in the production department and make up the skilled work force.

Included in the naval shipyard work force are apprentices and temporary employees. The apprentices participate in a four-year training program leading to a journeyman's rating in a trade. Temporary employees are hired on a short-term basis when there are unusually heavy workload demands for labor. Both these categories of workers are included in manpower ceilings imposed on the naval shipyards.

The skilled work force is distributed throughout the production shops, each of which has a functional title and a numerical designation.[1] As discussed earlier, there are four groups of shops, structural, mechanical, electrical, and service, with a group superintendent managing the shops under his cognizance. The percentage distribution of labor within these four groups for the eight naval shipyards is shown in Table 15. Variations in this distribution are attributable to the workload mix resulting from shipyard mission assignments, layout of shipyard facilities, and differences in organizational structures and management philosophies.

Each production shop basically employs a particular trade, which encompasses many skills. For example, the shipfitter trade includes the skills of caulker, chipper, reamer, riveter, loftsman, and many others. Workmen can be identified as to their assigned shop by the color coding of their hard hats and by the numerical designation of the shop imprinted on these hats. The Navy is attempting to standardize specifically defined functions, processes, operations, and services, into functional work groups (FWG) within the

[1]NAVSHIP Instruction 5450.152A, "Relationships of Organizational Code Numbers to Standard Shop Numbers and Expense Center Numbers."

Table 15. DISTRIBUTION OF LABOR WITHIN SHOP GROUPS IN NAVAL SHIPYARDS

Shipyard	Shop Groups (percentage of total shop employment)			
	Structural	Mechanical	Electrical	Service
Portsmouth	35.0	21.0	13.0	31.0
Philadelphia	25.0	34.0	19.0	22.0
Norfolk	25.0	37.0	17.0	21.0
Charleston	22.0	34.0	18.0	26.0
Long Beach	22.0	31.0	23.0	24.0
Mare Island	32.0	29.0	17.0	22.0
Puget Sound	25.0	41.0	14.0	20.0
Pearl Harbor	32.0	25.0	19.0	24.0
All	26.5	32.7	17.6	23.2

Source: Naval Sea Systems Command, "Statistics of Naval Shipyards," Washington, D.C., 30 June 1974.

production shops, which would provide a common base for analysis, planning, and forecasting.

Appendix J contains a list of the production shops and the functional work groups that relate primarily to each shop. The work group is further split into functional work items and functional work elements. These two breakdowns permit identification of skills within a trade, the equipment a workman is qualified to use, and in many instances, the type of equipment or machinery the workman is qualified to repair or install.[1]

[1]Following is an example from NAVSEA Instruction 4870.1.

Major function at shop level:	Welding
Functional Work Group:	Weld Service—Ship
Functional Work Item:	Tack Weld
Functional Work Element:	Tack Weld, Electric Arc

The naval shipyard skilled labor force is composed largely of career civil service employees; therefore, shipyard management is limited in the short run in its ability to match the proper mix of skills to changing workloads. As mentioned earlier, temporary employees may be hired to handle short-term requirements, but the success of this alternative depends on the availability of suitable workers when needed.

If naval shipyard skilled labor could be trained in related secondary and tertiary skills, management would enjoy greater flexibility in handling assigned workloads. For example, it appears that shipfitters could be cross-trained as sheetmetal workers and vice versa. Opposition from the labor unions would probably have to be overcome to implement such a program, but cross-training could be a very useful action to improve the efficiency of shipyard operations.

The Navy accumulates historical labor data in terms of manhours or mandays. These data, which are updated periodically, show the amount of labor used to perform various types of work. From these data, the Navy has developed shop standards that describe the time-phased distribution of labor required to perform specific tasks associated with shipyard work. These standards are employed in computer programs to facilitate the planning and programming of Navy ship work. The curves of most interest in this discussion are for regular overhaul, restricted availability, and new construction.

a. Repair

Many naval shipyard officials maintain that repair work requires a more highly skilled mechanic than does new construction.[1] Repair work requires a determination of what needs to be done

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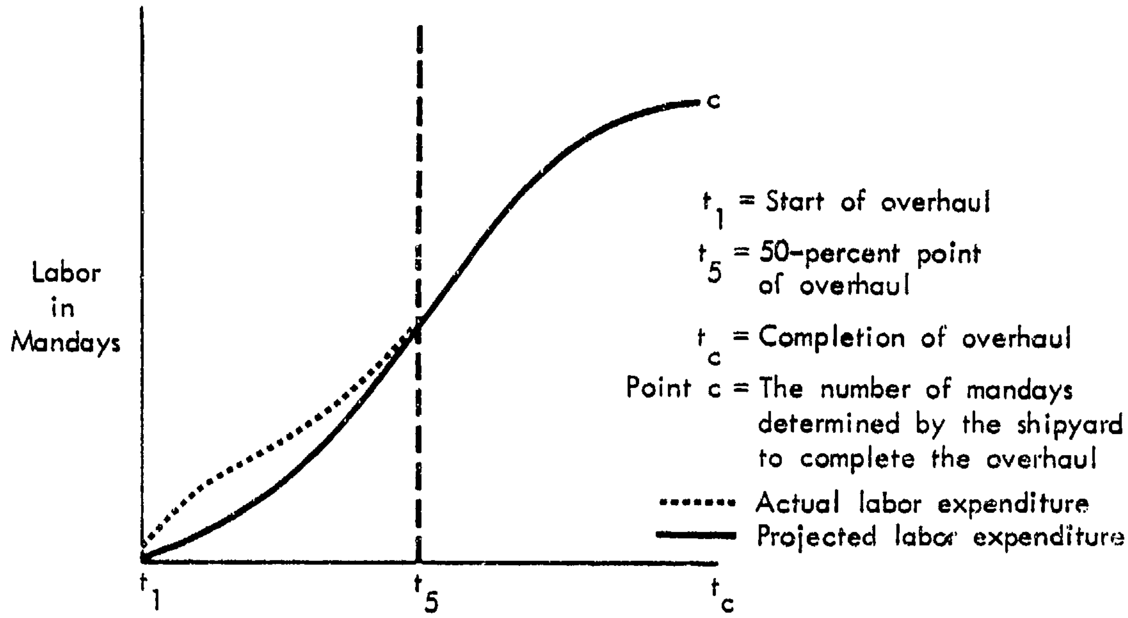
[1]From discussions with management officials at the Portsmouth, Philadelphia, Norfolk, Long Beach, and Puget Sound Naval Shipyards. Some officials had over thirty years experience in shipyards, and it was from this experience that the observation was made.

and how best to accomplish the work. Trouble-shooting and systematic checking and testing using various pieces of test equipment are necessary steps in the determination process. In new construction work, on the other hand, most of the workers' operations are well-defined in the construction plan. Although the naval shipyards are now engaged exclusively in repair work, some of their labor forces include a residue of skilled workers who were engaged in building ships before new construction was removed from the naval shipyards.

Descriptive words or phrases that characterize the functions performed by skilled labor in repair work are: remove interferences, cut accesses, dismantle, remove to shop, disassemble, take measurements and readings, secure material, fabricate parts, reassemble, bench test, return to ship, reinstall, system test, and restore interferences and accesses.

The repair process for a naval shipyard starts with the planners and estimators who survey the work requested, write job orders, and estimate the material needed to perform the repair. The material is then ordered in advance to have it available in the shipyard when the ship arrives for repair. Since labor is a high-cost resource and in order to preclude schedule delays because of material shortages, shipyard managers consider it more efficient to risk ordering more material than may be used on certain jobs so progress will not be halted on a job while awaiting material.

Figure 18 illustrates cumulative labor curves used in displaying progress in naval shipyard work. These curves are used to show actual versus scheduled labor hours expended over the time period of a ship overhaul. Initially, a curve is drawn that projects the scheduled expenditure of labor over the duration of the overhaul. Actual labor expenditures over time are plotted against the projected curve. Any variance between the two curves can be analyzed and corrective action taken as needed.



Source: Discussions with the Commander, Norfolk Naval Shipyard.

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Figure 18. EXAMPLE OF CUMULATIVE LABOR CURVES USED IN NAVAL SHIPYARDS TO SHOW PROGRESS OF OVERHAULS

During the first part of the overhaul, the machinery and equipment areas of the ship are literally dismantled and much of the machinery and equipment removed from the ship to various shops. During this period progress is difficult to measure, but it relates directly to the number of mandays applied. Therefore, management during this phase of the overhaul is primarily management of manpower.

One of the methods used by naval shipyard managers to check manpower utilization is the activity check which shows how many shipyard workers are idle at the time the check is made. Frequent movement of workers around the waterfront is common in most shipyards. The reasons for these movements of shipyard workers can be placed in four categories: going for

(1) tools, (2) material, or (3) software, e.g., blue prints, instruction books, diagrams, and (4) for personal reasons. The first three reasons for movement are controllable to a large degree through proper planning and scheduling and by pushing the decision as to how the job is to be done down to the lowest level of management. The fourth reason is primarily controllable with effective first-line supervision.

The second part of the overhaul involves the reassembly and testing of ship machinery and equipment. Progress during this phase is a function of testing, which is a start-and-stop operation, and progress is relatively easy to measure. The key management technique during this phase of the overhaul is to manage momentum by events and milestones. Management contemplates the various actions that must be taken to maintain momentum and plans and schedules accordingly, ensuring that necessary tools, equipment, and materials are available where and when needed.

b. Nuclear Repair

Skilled workers engaged in nuclear work must pass physical examinations and receive special training. The training covers nuclear decontamination, safety, and improving trade skills. The latter is important because of the stringent standards applied to nuclear work. Another form of training unique to nuclear work is performing repair on mock-ups of machinery or components in order to increase proficiency. Time on the actual job is also reduced, which minimizes exposure of the worker to radiation hazards.

Table 16 compares the personnel distribution in nuclear versus non-nuclear naval shipyards. Philadelphia and Long Beach, the only two non-nuclear naval shipyards, are compared with two nuclear submarine yards, Portsmouth and Mare Island. As shown in the table, about 5 percent of the total work force in the two nuclear shipyards is employed in

Table 16. PERSONNEL DISTRIBUTION COMPARISON--NUCLEAR VERSUS NON-NUCLEAR NAVAL SHIPYARDS

Department/Office	Nuclear				Non-Nuclear			
	Portsmouth		Mare Island		Philadelphia		Long Beach	
	#	%	#	%	#	%	#	%
Shipyard Commander's Office	3	z	7	z	5	z	2	z
Radiological Control Office	70	1.2	79	1.0	0	0	0	0
Data Processing Office	74	1.3	76	0.9	79	1.2	85	1.1
Ship Management Officer Staffs	0	0	6	0.1	0	0	3	z
Quality Assurance Office	308	5.4	418	5.0	120	1.8	110	1.5
(Nuclear Inspection Division)	(87)	(1.5)	(147)	(1.8)	0	0	0	0
Management Engineering Office	12	0.2	10	0.1	8	0.1	11	0.1
Industrial Relations Office	55	1.0	92	1.1	71	1.0	84	1.1
Combat Systems Office	67	1.2	80	1.0	88	1.3	117	1.6
Planning Department	650	11.4	1,027	12.4	595	8.8	665	8.9
Production Department	3,304	58.1	5,297	63.6	4,482	66.3	5,569	74.6
Public Works Department	416	7.3	585	7.1	583	8.6	431	5.8
Supply Department	328	5.8	310	3.7	439	6.5	259	3.5
Comptroller Department	84	1.5	90	1.1	93	1.4	78	1.0
Medical Department	11	0.2	0	0	0	0	0	0
Dental Department	3	z	0	0	0	0	0	0
Administrative Department	137	2.4	41	0.5	187	2.8	27	0.4
Nuclear Engineering Department	110	1.9	178	2.1	0	0	0	0
All Other	56	1.0	3	z	55	0.8	28	0.4
Total	5,688		8,301		6,760		7,469	

Note: z = less than1/10 of one percent

Source: *Statistics of Naval Shipyards*, Table 3, "Number of Employees in Departments and Divisions of the Naval Shipyards," June 1974.

nuclear-dedicated organizations (i.e., the Radiological Control Office, the Nuclear Engineering Department and the Nuclear Inspection Division of the Quality Assurance Office). Although not shown in the table, the corresponding percentages for Charleston, Puget Sound and Pearl Harbor range from 5 to 7 percent. Currently, only about 2 percent of the total work force at Norfolk is assigned to these functions since only limited nuclear work is accomplished. As work expands in the surface nuclear area, manning levels would be expected to increase.

These data show that a significant part of the total work force in naval shipyards that performs nuclear work is employed in three nuclear-dedicated organizations. These personnel do not, however, represent the total number of additional personnel required because of the nuclear workload. The total number of additional personnel required in the production, planning, public works and supply departments could not be determined with the data made available to IDA.[1]

c. New Construction

As indicated earlier in this chapter, new construction is more of a production-line process than is repair and may be described as a sequential process in which each craft performs its work in accordance with the scheduling of construction through the facility. The work is controlled by the flow of material, primarily steel plate in the hull-erection process. The outfitting or installation of machinery, equipment, piping, electrical cables, and fixtures commences during the latter phase of the hull-erection process. These activities continue until the ship is completed and is ready for trial run prior to being placed in service.

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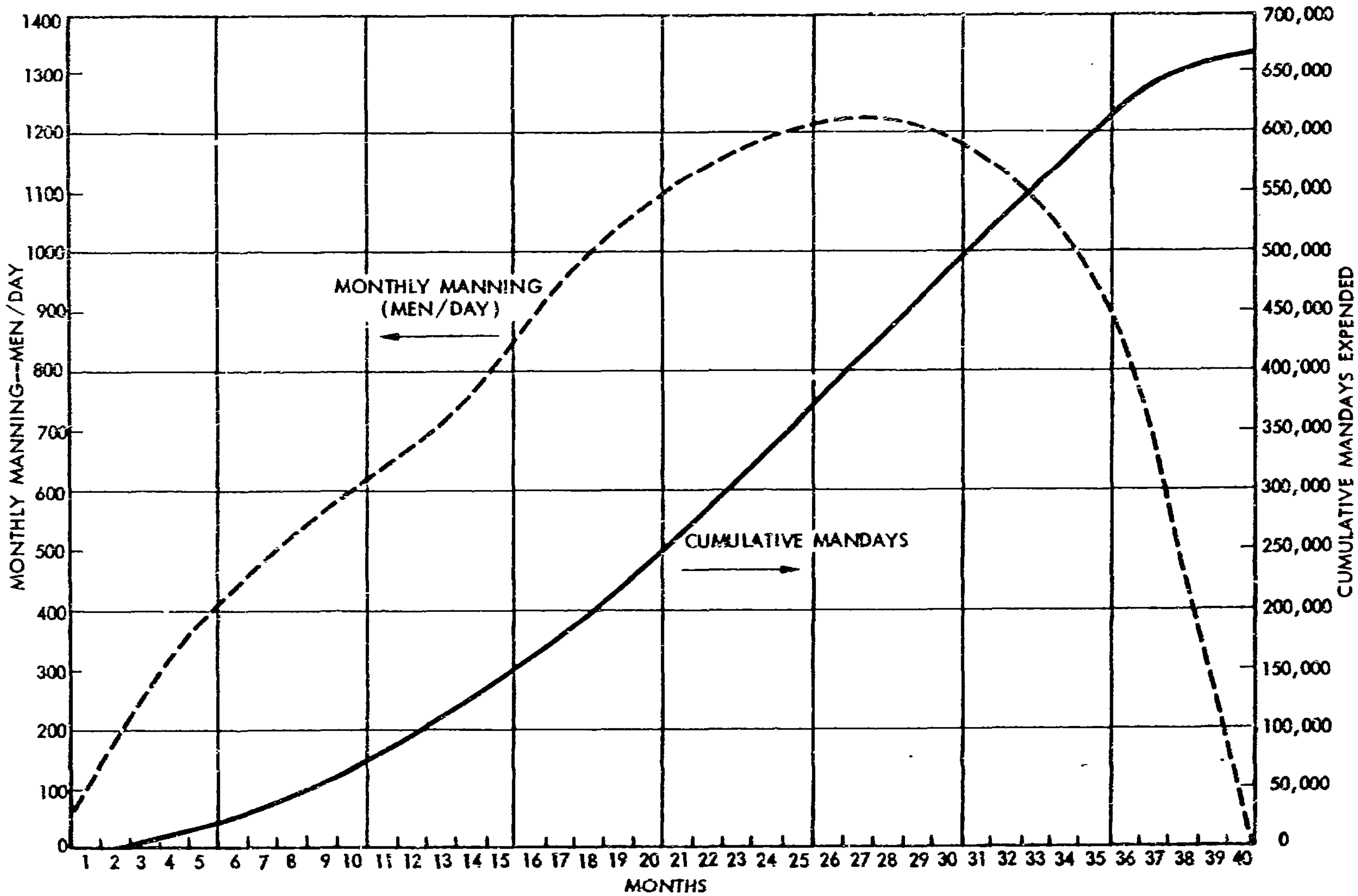
[1]See Section A2 of this chapter (page 25) for a discussion of some of the organizational differences in nuclear and non-nuclear naval shipyards.

Table 17 displays a sample distribution by shop of production manpower for new construction of a nuclear-powered guided-missile frigate (DLGN) over a 40-month building period. From this table it is apparent that the shipfitter and welding shops provide most of the labor during hull-erection. It is not until the nineteenth month that another shop's manning exceeds shipfitting or welding. Two shops, boiler and electronics, do not provide manpower until near the end of the first year's construction.

Figure 19 depicts the monthly manning in men-per-day and the cumulative mandays expended during this same 40-month building period. The peak manning occurs during the twenty-eighth month of construction, when most of the shops other than shipfitting or welding are at or near their peak manning.

The trades involved in ship construction are basically the same as those used in repair, but the mix of trades and the phasing of that mix over the construction period vary significantly from repair. A comparison of manpower distribution by shop during new construction and repair is presented in Table 18. New construction versus regular overhaul of DLGNs and new construction versus regular overhaul and restricted availability for nuclear-powered submarines (SSNs) are displayed. The distribution of production manpower by shop for SSN regular overhaul and SSN restricted availability as shown in Table 18 are essentially the same. Comparing these percentages with the SSN new construction manpower distribution percentages on the same table indicates that the shipfitter, sheetmetal, and welding shops expend significantly higher percentages of manpower for new construction than for repair work.

The comparison of the manpower distribution percentages by shop for DLGN new construction and regular overhaul reveals a similar pattern, with two major exceptions. In the pipe



Source: NAVSEA Industrial Activity Work and Resources Planning Division.

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Figure 19. MONTHLY MANNING AND CUMULATIVE MANDAY EXPENDITURE FOR NEW CONSTRUCTION, DLGN

Shops	Month From Start of Construction																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Shipfitter	28	61	84	108	126	138	143	149	159	168	172	173	175	177	178	180	179	179	176	172	167	161
Welding	18	49	86	127	157	182	206	225	235	245	253	254	253	252	248	244	240	236	233	227	221	214
Sheetmetal								2	6	10	13	18	24	31	40	48	56	63	69	75	81	86
Boiler												2	2	3	3	3	3	3	3	4	4	4
Pipe	2	4	8	9	11	13	17	19	22	27	35	45	54	65	79	108	148	177	192	201	212	221
Weapons							1	1	1	1	2	2	2	2	3	3	3	3	3	3	2	2
Forge			1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4	4	4	4
Inside Machine	1	2	2	3	4	5	6	7	10	13	19	25	32	36	40	43	44	46	47	48	49	50
Outside Machine				1	2	3	3	4	4	5	6	7	9	13	22	32	48	59	63	65	66	67
Pattern	1	2	2	3	3	3	4	4	4	4	4	5	5	5	5	5	5	5	4	4	3	2
Electrical				1	2	3	4	4	5	6	6	9	13	17	21	26	34	42	54	69	98	119
Electronics												1	1	2	2	3	4	5	7	8	11	14
Woodworking	3	6	8	10	11	13	14	15	16	17	18	20	21	22	23	24	25	26	27	29	33	37
Paint	2	5	9	11	12	13	14	15	15	16	16	17	17	18	18	19	19	19	19	20	20	20
Rigging	4	10	14	18	21	25	28	30	33	36	39	43	47	50	54	58	62	64	67	69	71	73
Temporary Services	1	3	6	9	13	16	20	23	27	31	34	37	40	43	46	48	50	52	54	55	56	58
TOTAL	60	142	220	301	363	415	461	499	539	581	618	660	697	738	785	847	923	982	1022	1063	1098	1132

Source: NAVSEA Industrial Activity Work and Resources Planning Division

Table 17. DISTRIBUTION OF PRODUCTION MANPOWER BY SHOP FOR NEW CONSTRUCTION OF A DLGN: AVERAGE MEN EMPLOYED PER DAY DURING EACH MONTH OF CONSTRUCTION

Month From Start of Construction																						Total Mandays Per Shop
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
176	172	167	161	155	144	136	127	117	108	99	90	81	73	63	54	43	35	21	14	9	3	97833
233	227	221	214	209	201	196	189	179	169	158	141	123	106	87	70	50	35	28	21	11	4	134354
69	75	81	86	91	96	99	102	106	108	109	109	108	104	99	90	61	47	42	32	21	7	43070
3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	2	1	1	1	1			1806
192	201	212	221	228	263	266	270	272	263	266	270	272	274	276	277	276	273	240	96	54	13	121015
3	3	2	2	2	2	2	2	1	1	1	1	1	1									1020
4	4	4	4	4	4	3	3	3	3	3	2	2	2	1	1	1						1631
47	48	49	50	50	50	50	50	49	48	44	39	34	28	22	17	14	12	9	6	4	2	22368
63	65	66	67	67	71	82	87	89	92	93	95	96	96	97	98	99	99	98	45	34	16	40469
4	4	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1			2062
54	69	98	119	127	137	145	153	160	166	169	172	175	175	173	170	166	147	129	92	63	23	64498
7	8	11	14	17	20	23	26	29	32	35	38	41	43	45	47	49	50	50	49	40	9	14810
27	29	33	37	41	46	51	55	59	63	66	69	72	73	74	75	65	30	30	20	12	4	27628
19	20	20	20	20	20	21	21	21	22	23	25	26	28	30	31	33	33	35	34	30	12	16705
67	69	71	73	75	76	77	78	80	81	83	84	85	85	85	85	84	81	80	75	59	14	47940
54	55	56	58	59	60	62	63	63	63	63	64	63	60	56	52	51	49	46	41	31	17	35347
1022	1063	1098	1132	1151	1171	1198	1213	1220	1224	1217	1204	1184	1153	1112	1070	994	893	810	527	368	124	673556

Table 18. DISTRIBUTION OF PRODUCTION MANPOWER
(Percentages by Shop)

Shop	No.	SSN			DLGN	
		Regular Overhaul	Restricted Availability	New Construction	Regular Overhaul	New Construction
Central Tool	06	0.3	0.3	0.8	0.1	--
Shipfitter	11	6.6	7.8	16.2	6.7	14.7
Sheetmetal	17	3.6	3.4	6.0	4.7	6.4
Forge	23	0.2	0.2	1.1	0.3	0.3
Welding	26	5.4	5.5	17.7	6.4	20.0
Inside Machine	31	9.7	9.6	9.0	8.9	3.3
Weapons Systems	36	0.4	--	2.5	1.3	0.2
Outside Machine	38	15.5	16.3	8.2	10.8	6.0
Boiler	41	0.4	0.4	0.2	3.8	0.3
Electric	51	11.4	10.6	7.3	17.8	9.6
Pipe and Copper	56	20.1	18.0	13.7	9.8	17.9
Woodworking	64	3.1	4.4	4.2	3.8	4.1
Electronics	67	4.7	4.0	0.8	11.5	2.2
Paint	71	4.1	4.2	2.7	3.2	2.4
Rigging	72	11.1	11.3	7.5	8.2	7.1
Pattern Making	94	--	--	--	--	0.3
Temporary Services	99	3.4	4.0	2.1	2.7	5.2

Source: Derived from NAVSEA manpower distribution curves.

and temporary services shops, the manpower percentage for new construction is nearly double that for regular overhaul.

Table 18 shows that during new construction the structural trades expend a large portion of the total mandays, but during repair work a larger percentage of the total mandays is expended by the mechanical and electrical trades.

Another way to portray differences in manpower skill requirements associated with repair and new construction is to compare the production department manning in a selected shipyard under the two different workload conditions--when the shipyard was performing primarily new construction compared with when the same shipyard was engaged primarily in repair. Table 19 and Figure 20 show such a comparison in terms of the percentage changes in each shop. The percentage change column reflects the value of the differences between the new construction and repair columns divided by the value in the new construction column. Ten of the sixteen shops displayed in Table 19 experienced at least a 34 percent change in manpower strengths when the workload was primarily repair as opposed to new construction.

To reverse the situation and go from repair to new construction, similar significant changes in the work force mix would occur. Officials from NAVSEA told the House Seapower Subcommittee in 1974 that a major effort would be required to resume new construction in a naval shipyard that now has inactive shipbuilding facilities.[1] The lead time from assignment of new construction to the laying of the keel of the first ship would range from 18 months for a relatively simple surface ship to 42 months for a more complex combatant ship. This lead time would be required partially to increase the personnel manning in the design division, hire new people, and reorient the trade structure in the production department and to train employees for new construction.

[1] *Current Status of Shipyards, op. cit.*, Part 1, p. 598.

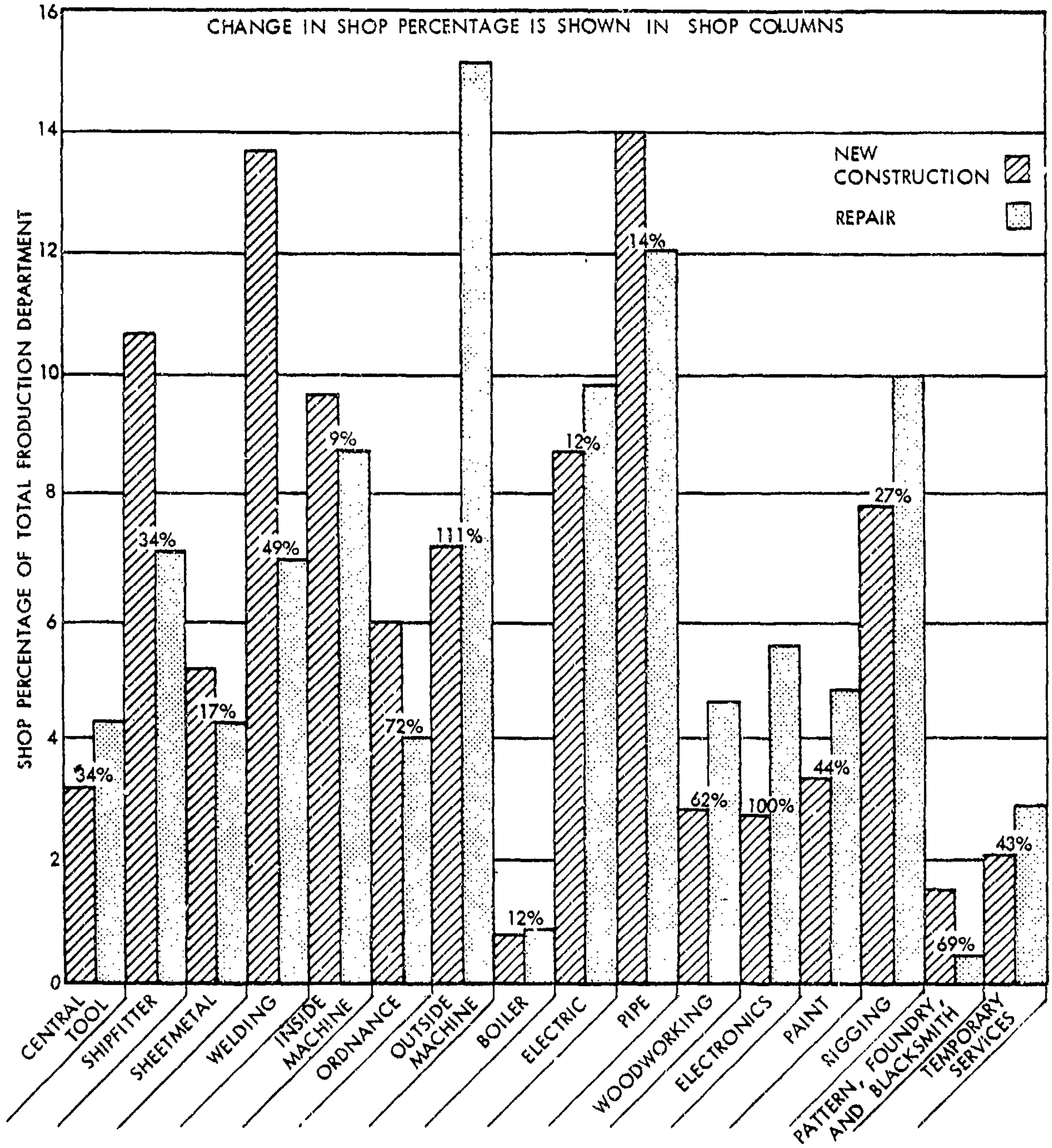
Table 19. COMPARISON OF NAVAL SHIPYARD PRODUCTION SHOP MANPOWER UNDER SHIFTING WORKLOADS[1]

(Percentage of Total Production Department Manpower by Shop)

Shops	Primarily New Construction	Primarily Depot Maintenance	Percent Change
Central Tool	3.2	4.3	+ 34
Shipfitter	10.7	7.1	- 34
Sheetmetal	5.2	4.3	- 17
Welding	13.7	7.0	- 49
Inside Machine	9.7	8.8	- 9
Ordnance	6.0	1.7	- 72
Outside Machine	7.2	15.2	+111
Boiler	0.8	0.9	+ 12
Electric	8.8	9.9	+ 12
Pipe	14.0	12.1	- 14
Woodworking	2.9	4.7	+ 62
Electronics	2.8	5.6	+100
Paint	3.4	4.9	+ 44
Rigging	7.9	10.0	+ 27
Pattern, Foundry, and Blacksmith	1.6	0.5	- 69
Temporary Services	2.1	3.0	+ 43
Total	100.0	100.0	

[1]This table shows what happened in the production department of a typical naval shipyard when it shifted from 80 percent of the production effort on new construction to 79 percent on conversion, alteration and repair.

Source: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part I, p. 598.



Source: U.S. Congress House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., Part 1, July-October 1974, p. 598.

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Figure 20. SHOP PERCENTAGE OF TOTAL PRODUCTION DEPARTMENT IN A NAVAL SHIPYARD, NEW CONSTRUCTION VERSUS REPAIR

Asked by IDA for an estimate of additional manpower required to build SSN-688 class submarines while continuing normal repair work in a naval shipyard,[1] NAVSEA responded that "the total shipyard employment increase required to meet the new construction requirements on top of normal CAR work at either Mare Island or Portsmouth Naval Shipyards would be approximately 3,200-3,600 employees."[2] Of this total increase in shipyard employment, about one-half would be production shop employees. The NAVSEA letter further stated:

> If the level of CAR workload is assumed to be 3000-3200 production shop manyears, approximately 1700 additional production shop employees would be required to meet peak new construction requirements. That would primarily be needed in five production trades as follows:
>
> | | | | |
> |---|---|---|---|
> | Shop 56 | Pipe | - | 250 |
> | 26 | Weld | - | 350 |
> | 11 | Structural | - | 400 |
> | 31 | Machinist | - | 170 |
> | 38 | Machinist | - | 170 |
>
> Note: The above numbers are an order of magnitude approximation which would vary with the total workload mix and the actual numbers employed in those trades at the time. Other skilled labor would be required in less significant numbers. Design, engineering, planning, quality assurance, quality control, supply and material control areas would have to be increased as would other direct and indirect areas. Design would require approximately 240-300 men build-up within the first 16 months. A detailed analysis by the specific shipyard involved would be required to ascertain accurately the exact numbers of personnel required in each of the above areas.[3]

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[1]NAVSEA letter, serial 415, *op. cit.* The acronymn CAR used by NAVSEA covers conversion, alteration and repair workloads. We use the term depot maintenance to cover these workloads.

[2]IDA proposed building submarines in series construction such that as the structural work on the first ship declines, work on the second ship begins and similarly for succeeding ships.

[3]NAVSEA letter serial 415, *op. cit.*

The NAVSEA analyzed the capacity of the eight naval shipyards to perform only repair work on a peace-time, one-shift basis using existing facilities and equipment and concluded that maximum employment for the eight shipyards was 76,700 employees.[1] This compares with an employment level of about 60,000 employees as of June 1974. The NAVSEA also studied the impact on manpower if new construction were placed in the four naval shipyards possessing new construction capabilities. The results of the NAVSEA analysis are presented in Table 20. The combined workloads of repair and new construction placed in the yards result in a total work force of 82,500 employees. At this level of employment, facilities constraints became the limiting factor for both the work force performing repair and the work force performing combined repair and new construction. The Navy analysis indicated that the current manning of the eight shipyards roughly corresponded to the capacity that would remain to perform conversion, alteration and repair if new construction were undertaken in four naval shipyards in addition to repair work.

Theoretically, it can be concluded that if the eight naval shipyards hired the required skilled labor up to their peace-time, one-shift capacity, some new construction could be added in four naval shipyards while maintaining the same level of repair as is currently being accomplished.[2] Practically speaking, an analysis of the repair workload would be required to determine if unusual requirements exist for drydocks or for the services of certain shops. The shops would support, in varying degrees, both new construction and repair.

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[1] *Current Status of Shipyards, 1974, op. cit.*, pp. 595-596.

[2] In addition, depending upon the workload mix desired, various other combinations are possible. For example, if only the four new construction yards are permitted to hire to capacity and the remaining four yards maintain their current levels of employment, total manpower available for depot maintenance would be about 10 percent below current levels.

Table 20. NAVAL SHIPYARD CAPACITY, PEACETIME, ONE-SHIFT EMPLOYMENT

Shipyard	Repair	With New Construction		
		New Construction	Repair	Combined
Portsmouth	7,000	5,000	3,000	8,000
Philadelphia	11,000	2,500	9,500	12,000
Norfolk	12,000	--	12,000	12,000
Charleston	8,500	--	8,500	8,500
Long Beach	9,000	--	9,000	9,000
Mare Island	10,500	6,000	6,500	12,500
Puget Sound	12,200	8,000	6,000	14,000
Pearl Harbor	6,500	--	6,500	6,500
Total	76,700	21,500	61,000	82,500

Source: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part I, p. 595.

Navy officials differ in their opinions with regard to resuming new construction in naval shipyards. Some officials favor placing new construction in naval shipyards to provide an additional resource of skilled labor that could be assigned to high priority repair work on an "as needed" basis. This is essentially the situation that prevailed in naval shipyards in the past. New construction was used for its "fly wheel" effect or surge capability. Other Navy officials believe that if new construction were again placed in naval shipyards it should be done only with a dedicated work force for new construction and with series production. Under these conditions, naval shipyards could possibly compete effectively with private shipyards as to time and cost to build ships.

The Navy has stated that under the "fly wheel" system new construction costs were about 30 percent higher in naval shipyards than in private shipyards.[1] The building duration was also considerably longer. The latter fact is confirmed by a quick review of the new construction of some of the SSN-637 class nuclear submarines. Between 1963 and 1973, two private shipyards built the majority of these submarines and a few were built in two naval shipyards. The average building duration for the two private shipyards was two years-seven months and three years, respectively.[2] The two naval shipyards averaged four years-three months and six years-one month, respectively. The two private shipyards built their vessels under the series construction concept. The two naval shipyards used the "fly wheel" approach.

On 26 September 1974, in testimony before the Seapower Subcommittee, the Chief of Naval Operations commented on the question of authorizing the Navy to perform new construction in naval shipyards:

> While it is not now apparent that this will be necessary, whenever it appears that the private shipyards cannot produce the Navy's ships, we will plan and budget for appropriate new construction in naval shipyards.... Civilian personnel ceilings imposed in the fiscal year 1975 authorization have been reflected in the area of the industrially funded naval shipyards and thus have largely obviated any early

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[1]Admiral I.C. Kidd, Jr., quoted in the *San Diego Union*, 3 March 1975. This statement is apparently based on the results of the 1972 Booz-Allen study referenced earlier. As pointed out in that study, these results are based on a limited sample and reflect conditions that existed in the FY 62-71 time period. For this reason, it is not appropriate to use these results as a basis for today's decisions. In addition, the Booz-Allen results are sensitive to assumptions made by them to achieve work and cost comparability. Thus, it is possible to change the 30 percent factor significantly if costs are imputed for the advantages that accrued to the Navy as a result of the "fly wheel" system.

[2]The building duration as used in this comparison is the period from keel laying to commissioning.

ability to resume a new construction capability in the naval shipyards.[1]

In testimony before the same committee, the Deputy Secretary of Defense stated:

> I believe a small portion of the Navy's annual Shipbuilding program (perhaps 10%) should be assigned to the naval shipyards. There are two reasons. The obvious reason relates to the need to maintain a stable work force and to insure the immediate availability of a surge capability for use in emergencies. The less obvious reason--and to me a more profound reason--is the need to nurture and maintain in the Navy's technical engineering community a degree of expertise in shipbuilding and weapon systems integration.[2]

An alternative to placing new construction work in naval shipyards simultaneously engaged in repair work would be to dedicate a naval shipyard entirely to new construction. The IDA team could find no evidence that the Navy has studied this alternative, and the alternative was not analyzed in this study.[3] Some Navy officials were reluctant to comment on the feasibility of this alternative. A shipyard dedicated to new construction is contrary to what the Navy presently considers the primary reason for the existence of naval shipyards--quick-reaction capability. Navy officials point out that the current and projected repair workloads will fully utilize the manpower-constrained capacities of the eight naval shipyards even if a manpower growth up to a repair employment level of 76,700 is permitted. The Navy may also fear that devoting an entire shipyard to new construction could, in the

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[1]*Current Status of Shipyards, op. cit.*, Part 3, p. 1517.

[2]*Ibid.*, p. 1538.

[3]Senior naval officials, in discussions with the IDA team, did state that they would not favor this alternative because they believed that there would be severe manpower problems in shifting from 100 percent repair workload to 100 percent new construction. They felt it would take many months to realign the skills.

future, result in the closure and loss to the Navy of that shipyard. A shipyard engaged solely in new construction could become a prime candidate for closure if future economic or political factors force the Navy, once again, to place all new construction in the private sector.

Another alternative that might be considered would be to reopen a currently closed naval shipyard, such as Hunters Point, and then select one yard of the nine and dedicate it to new construction. This proposal maintains eight naval shipyards engaged in repair. Such a proposal would have to be studied in depth to determine the costs involved versus the benefits to be gained. If the Navy is unable to have ships built in the private sector at a suitable price, an alternative must be sought.[1] Reopening a shipyard could represent such an alternative. This would provide the Navy an opportunity to build ships on a basis comparable with private shipyards since Navy new construction could not be conducted under the "fly wheel" concept. In addition, it would provide baseline data on the cost of a given ship or class of ships. This issue will be discussed further in Chapter VII.

2. Manpower in Private Shipyards

The trades employed in private shipyards are the same as those employed in naval shipyards. The titles given to some of the trades vary among private shipyards and between private and naval shipyards. Although production shops in the private sector vary organizationally, they are essentially like naval shipyard shops, but with different titles. (Appendix K lists the titles of the naval shipyard shops and the

[1]The 1974 House Seapower Subcommittee hearings, *Current Status of Shipyards*, reveal that large segments of the private shipbuilding industry are reluctant to perform Navy new ship construction work because of low profit potential for this work and for other reasons associated with Navy contracting procedures.

equivalent titles found in private shipyards. This appendix also displays some of the various skills employed in the shops. Appendix K is a composite based on data submitted by about thirty private shipyards; thus all the skill titles would not be found in any one shipyard.)

Although there are significant differences in conditions of employment, manpower problems in private shipyards are similar to those in naval shipyards. Private shipyards, with few exceptions, are unionized and work under labor agreements that usually have a three-year term.[1] The labor agreements generally cover all areas of pay, fringe benefits, grievance procedures, training, and the division and assignment of work. More recent labor agreements have included procedures for cost-of-living pay adjustments.

The naval shipyards work under the Federal Personnel System administered by the Civil Service Commission. All federal employees are under the same system regardless of geographical location, so federal employee fringe benefits are essentially the same nationwide. This uniformity does not exist in the private sector. There are significant variations among regions of the country, for example, in both wages and fringe benefits among shipyard employees. Chapter VI discusses this area in more detail.

Private shipyards are experiencing the same skill shortages as naval shipyards. In many cases, the problem in the private sector is more acute because of recent required increases in the size of work forces and the lack of adequate apprentice training programs. Four repair yards and eight

[1]Labor unions also represent wage board employees in naval shipyards under the authority of Executive Order 11491, as amended. This executive order sets forth the areas in which the labor unions have a right to bargain with management. The interpretation of what areas are subject to bargaining is undergoing change; for example, annual leave is not bargainable since the earning of annual leave is prescribed by law. However, bargaining can address the procedures and methods for administering annual leave.

construction shipyards reported that they have apprentice programs, but these are usually limited to a few trades and fall far short of supplying the quantity of skilled personnel required.[1] Although precise data were not made available to the IDA team, many private shipyards acknowledged heavy losses of personnel who have recently completed the apprentice programs. The annual turnover rate of personnel throughout much of the private shipbuilding and repair industry is near 50 percent. This compares with an average turnover rate for naval shipyards in fiscal years 1971 through 1975 of about 8.5 percent.[2]

a. Repair

Although private shipyards engaged in repair work employ workers with the same skills as those in naval shipyards, the number of different skills required in the private shipyards is narrower. Repair yards are generally smaller in terms of size of physical plant and total employees than shipyards engaged in new construction. These repair yards depend upon subcontractors in many skill areas rather than maintain their own organic capability.

Ship repair work is a volatile business for private repair yards. Much of the work comes from unanticipated emergent repairs. Most of the repair work available from the Navy is awarded on a competitive bid basis. The volatility is shown in layoff and rehire statistics. Of twenty-two ship repair yards examined by Mark Battle Associates, annual layoffs reported in repair yards represented over 200 percent of the total production employment in those yards.[3] Of those laid

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[1]Mark Battle Associates, Inc., *Shipbuilding Manpower Study*, Washington, D.C., March 1974, pages 89 and 136. These results are based on their 1973 survey of 47 private shipyards.

[2]Naval Sea Systems Command, "Statistics of Naval Shipyards," Washington, D.C., June 1974, Table 8.

[3]Mark Battle Associates, *op. cit.*, p. 58.

off during the one year period of the Battle study, 82.5 percent were rehired. Layoff and rehire rates for the same period in construction shipyards were 29 and 43 percent, respectively. The workers in the private shipyards engaged in repair seemed to accept the fact that repair work involves frequent layoffs of short duration.

b. New Construction

All private shipyards engaged in new construction for the Navy also perform some repair work (including conversion). This discussion concentrates on the new construction aspects, but repair is a significant factor in most of these shipyards. The private shipyards that prefer new construction generally undertake repair work to fill-in the slack periods and help stabilize the workload and work force.

An example of what can happen to a private shipyard during a period when no new construction work is available is the case of a private shipyard that employed about 2,000 employees when the shipyard was performing new construction and repair. In about twelve months following completion of the last new construction contract, employment was reduced from 1,900 to about 200 employees. Management personnel were reduced from about 100 to 24. This residual number of employees represented a nucleus for expansion when new work became available. At the time of the IDA study, the employment level in the shipyard had increased to 2,000 as the result of new construction contracts.

As with the naval shipyards, the trades involved in new construction in private yards are the same as those found in ship repair yards, but the frequency distribution by trade is different. The structural skills are in much more demand for new construction, for example. To ease the requirements for structural labor and in many cases to expand shipbuilding facilities, especially for large commercial ships, many private

shipyards either have or are investing in automated labor-saving equipment and machines and in new facilities. The Commission on American Shipbuilding in its 1973 report cited the investments of seven private shipyards engaged in new construction as ranging from $18 million to $150 million.[1]

As mentioned above, shipyards engaged in new construction also perform repair work. To determine differences in labor distribution, an examination was made of the distribution of labor in a private shipyard performing new construction and repair work for the Navy and also commercial new construction. A four-year period was examined to determine differences in the application of trades for both overhaul and new construction.

Comparisons were made between submarine new construction and regular overhaul, and between new construction of a Navy ammunition ship and two commercial container ships. The data available for these comparisons combined some of the trades into eight groups, i.e., hull, production services, paint, inside machine shop, outside machine shop, pipe, sheetmetal, and electric.[2] A ninth group, "manufacturing support" was added to account for the remainder of the direct production labor, except engineering.[3] The eight groups were used by the private shipyard to tabulate direct labor manhours expended and costs. These eight groups were considered to be the eight critical areas that warranted management attention.

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[1]Commission on American Shipbuilding, *Report of the Commission on American Shipbuilding*, Washington, D.C., October 1973, Vol. 1, p. 10.

[2]The hull group included those trades involved in the hull-erection process or in repairs to the hull of the ship. Included are shipfitters, welders, burners, and loftsmen. Production services include riggers, crane operators, and similar trades. The other groups are single-trade oriented—except electric, which includes electronics.

[3]Manufacturing support includes the direct labor that supports the manufacturing process. Included are personnel who perform material functions, material handling equipment operators, quality assurance functions, testing functions, abrasive blasting, housekeeping, and similar activities.

Table 21 shows the results of this comparison. The distribution of direct labor is shown by percentage for each trade group in the private shipyard for regular overhaul and new construction of nuclear-powered submarines (SSNs),[1] new construction of a Navy ammunition ship (AE), and new construction of the two commercial container ships. Comparing the SSN regular overhaul with SSN new construction reveals major differences in the distribution of the hull, outside machine, and sheetmetal trades, and in the manufacturing support group. In SSN new construction, the hull trades expended over four times the manhours expended in SSN regular overhaul. In the outside machine and manufacturing support groups, fewer manhours were expended for SSN new construction than for SSN regular overhaul. This is a normal expectation considering the removal, repair, and reinstallation nature of overhauls and the stringent quality assurance and decontamination requirements associated with work on submarine nuclear power plant components. The other variations in the distribution of labor between SSN regular overhaul and new construction are of lesser magnitudes and their relationships are to be expected in view of the nature of the work involving each trade.

Figure 21 displays the total manpower level over time for SSN new construction and SSN regular overhaul. New construction involves a gradual buildup of manpower during the first 60 percent of the construction period, followed by a more rapid decline over the rest of the period. In the early months, workers in the hull trades comprise the largest part of the monthly manning requirements. As construction progresses, workers in the outfitting trades comprise an increasing part of the work force. The SSN overhaul requires a rapid buildup of manpower with heavy concentration on the outside machine, pipe,

[1]Percentages for SSN regular overhaul are the average for three SSN overhauls.

Table 21. DISTRIBUTION OF DIRECT LABOR MANPOWER--PRIVATE SHIPYARDS
(Percentages by trade groups)

Shops	SSN		Navy Ammunition Ship (AE)	Commercial Container Ships - New Construction	
	Regular Overhaul	New Construction	New Construction	Ship-A	Ship-B
Hull[1]	4.7	20.3	32.2	45.9	47.4
Production Services[2]	7.7	7.4	8.0	10.2	7.7
Paint	9.4	6.0	10.0	11.8	7.2
Inside Machine	2.0	3.4	1.0	1.0	0.6
Outside Machine	14.3	9.6	7.6	5.5	5.2
Pipe	15.6	18.1	14.2	12.8	13.2
Sheetmetal	2.4	7.6	6.8	2.8	4.5
Electric[3]	15.7	12.1	13.5	5.2	8.8
Manufacturing Support[4]	28.2	15.5	6.7	4.8	5.1

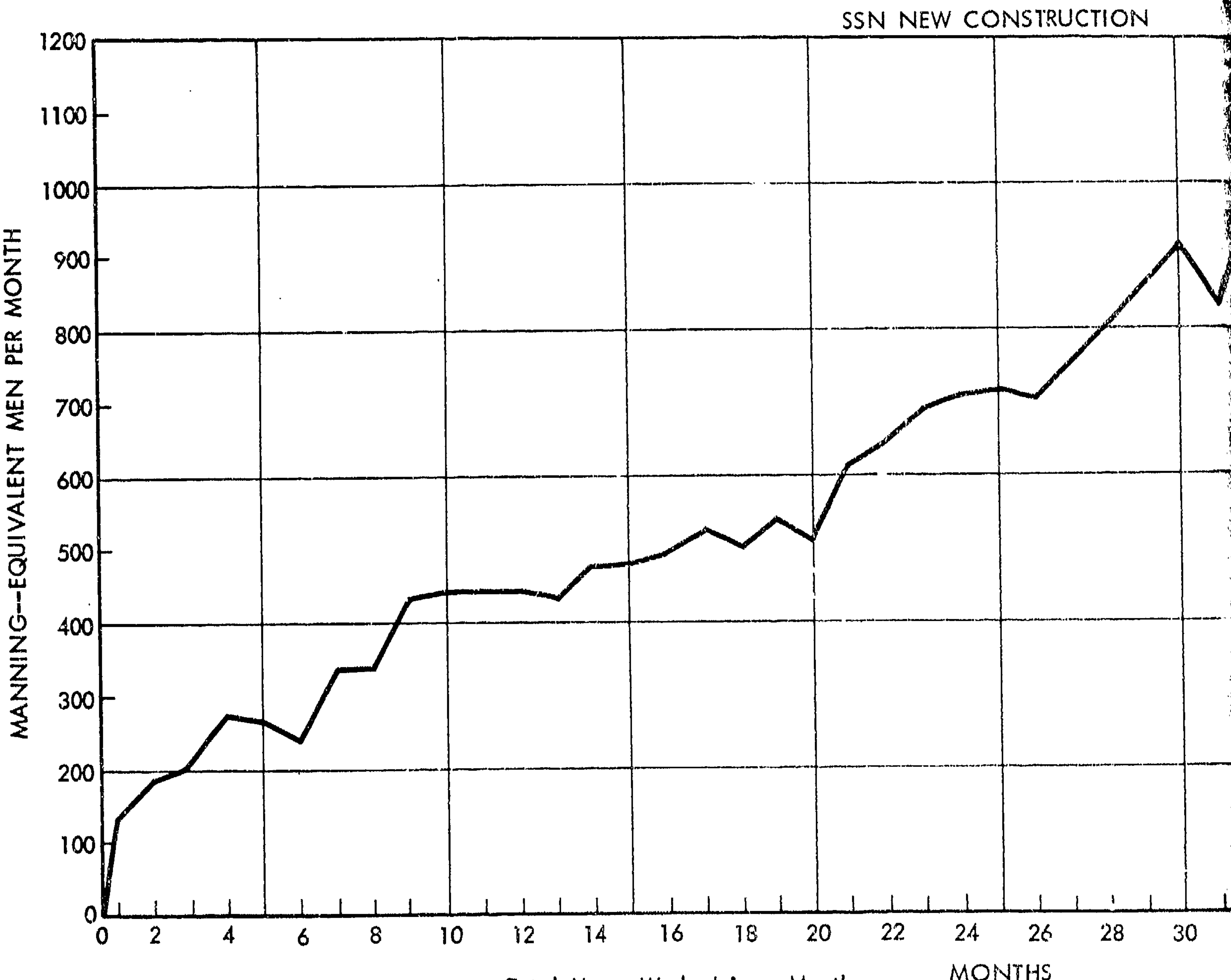
[1]Hull includes shipfitters, welders, burners, loftsman, etc.

[2]Production services include rigging functions, crane operators, and similar trades.

[3]Electric also includes electronics.

[4]Manufacturing support includes all other direct labor less engineering (such as quality assurance, material functions, abrasive blasting, housekeeping, etc.).

Source: NAVSEA progress reports.



Note: Equivalent Men Per Month = $\frac{\text{Total Hours Worked in a Month}}{8 \times \text{Number of Workdays in a Month}}$

Source: Data Provided by NAVSEA Shipbuilding Directorate.

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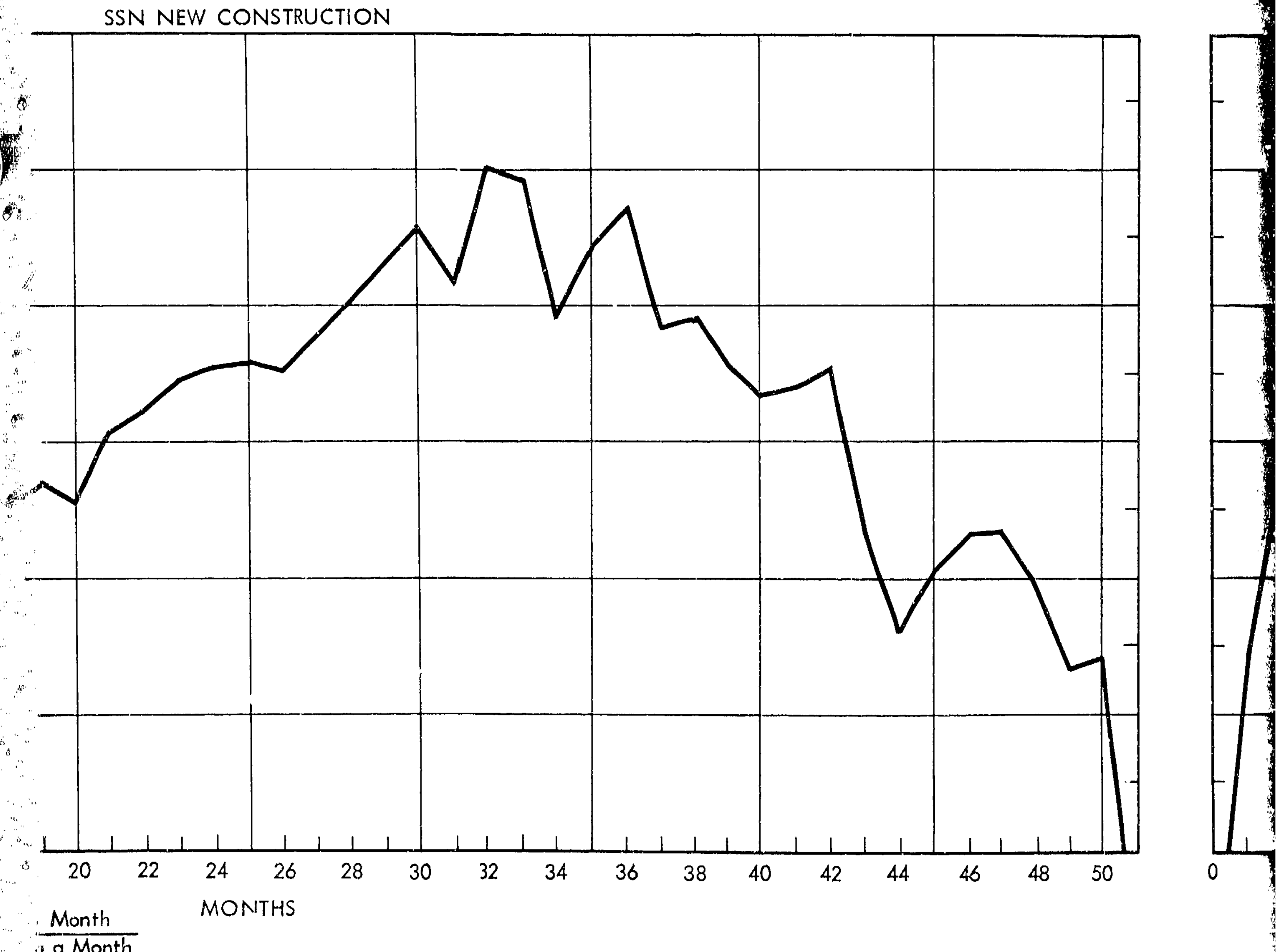

SSN NEW CONSTRUCTION
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
MONTHS
Month
a Month
0

Figu

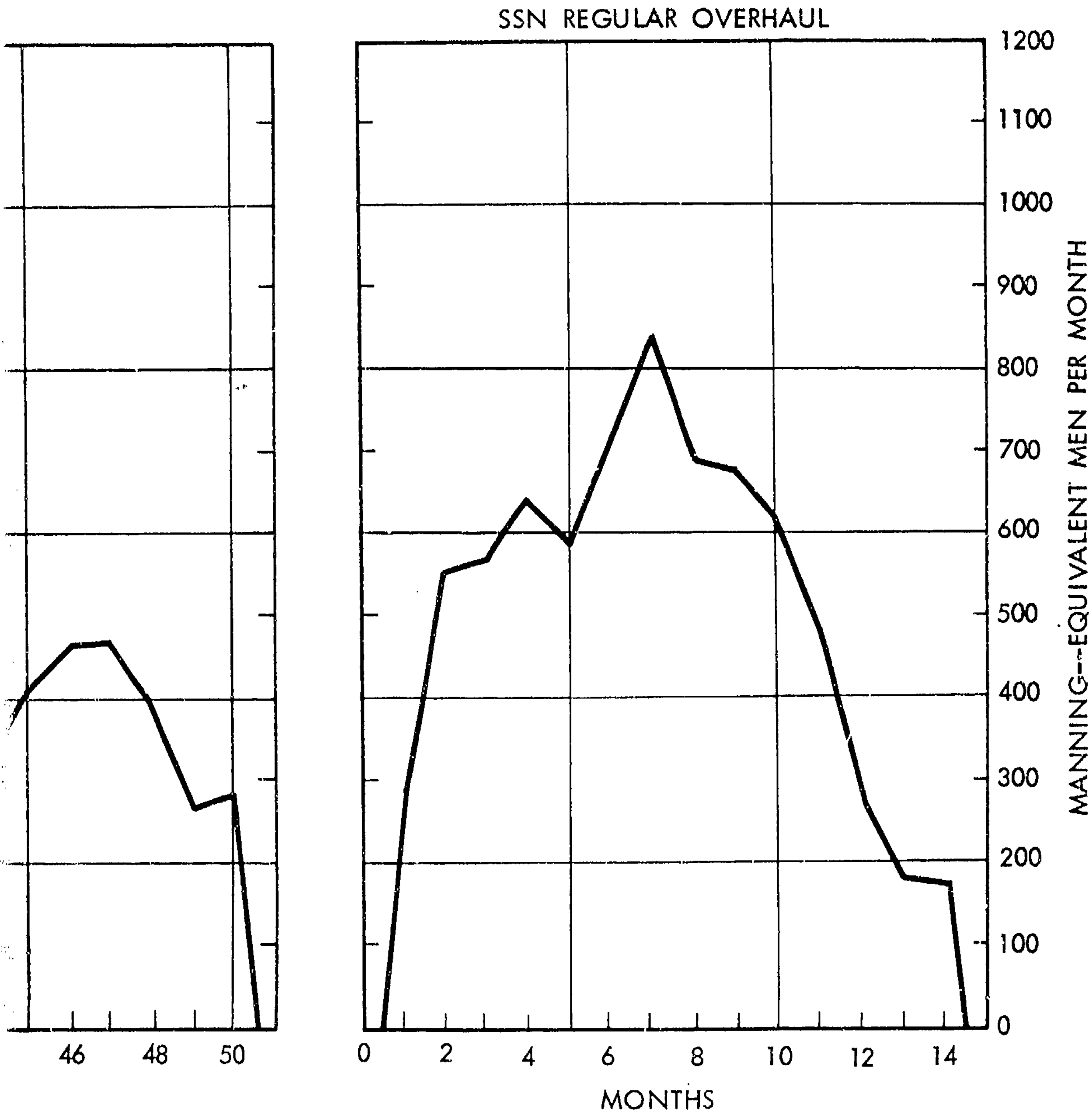

Figure 21. MANNING CURVES FOR SSN NEW CONSTRUCTION AND REGULAR OVERHAUL IN A PRIVATE SHIPYARD

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and electrical trades as well as the support areas. The SSN construction curve in Figure 21 has a shape similar to the DLGN construction curve in Figure 19. The irregularities in the SSN curve are based on a plot of historical data, while the smooth DLGN curve was a forecast. Although the SSN construction period was ten months longer than that of the DLGN, peak manning occurs at about the same percentage of completion, 64 percent for the SSN and 70 percent for the DLGN.

For surface ships, the only comparison possible was between new construction of Navy ammunition ships (AEs) and commercial container ships since surface ship repair was not performed by the private shipyard studied during the period examined. The Navy AE was the third of four ships constructed, while container ship "A" was the third of three and container ship "B" the second of four ships built. This comparison indicates that a much higher percentage of labor is expended by the hull trades for commercial ships than for the Navy AE. Conversely, a higher percentage of labor in the sheetmetal, outside machine, electrical trades, and in support functions is expended for Navy surface-ship new construction than for commercial surface-ship new construction. The results of these comparisons are to be expected because of the differences in ship configuration and the more complex equipment the Navy installs in its auxiliary surface ships as compared with commercial vessels.

3. Manpower Summary

The shipbuilding and repair industry is labor intensive and experiencing skilled labor shortages nationwide. The specific skill shortages and the intensity of the shortages vary in different regions of the country.

Naval shipyards have basically a standardized shop structure in which specific trades are employed. Minor variations are found among the eight naval shipyards, due primarily to

the layout of facilities and specific mission requirements. In private shipyards, there are many variations in the titles of shops and trades employed. The specific skill is more frequently used to identify the worker in private shipyards. Regardless of title differences, skilled labor in both the private and naval shipyards is essentially the same.

Movement of labor between the naval and private sectors occurs with most of the movement toward naval shipyards because of higher compensation. Personnel turnover rates are dramatically higher among private shipyards than in naval shipyards. The annual turnover rate for the private sector is about 50 percent as compared with about 8.5 percent for naval shipyards.

Skilled workers engaged in nuclear work are given additional training to increase their efficiency and skill qualifications. From 5-7 percent of the total work force in naval shipyards engaged in nuclear work are assigned to three nuclear-dedicated activities. The total number of additional people required in naval shipyards because of the nuclear mission was not determined in this study. No data for the private sector were available.

Manpower skills employed in new construction are the same basic skills employed in repair. The mix of skills is the main difference. Shipbuilding has heavy requirements for workers in the structural trades, i.e., welders, shipfitters, and sheetmetal workers, while repair uses relatively more of the mechanical and electrical trades.

Private shipyards have more flexibility than naval shipyards in adjusting the size of the work force to the workload. Union labor agreements provide some job protection to the private shipyard workers, but the private shipyard manager can lay-off labor with very little notice and hire on a short-term basis without concern for such restrictions as advance notice and personnel ceilings. The naval shipyards, on the other

hand, must adhere to strict requirements of Civil Service Regulations and inflexible manpower ceilings imposed by higher authority.

The Navy has four naval shipyards with some capability for new construction. These four yards, according to Navy sources, have the facilities to employ 21,500 workers in new construction. The time required to activate facilities, hire additional personnel, and train the work force for new construction varies from eighteen to forty-two months depending upon the complexity of the shipbuilding program. In addition, if all eight shipyards are permitted to hire to capacity, the same number of employees as is now performing depot maintenance will be available to perform depot maintenance in conjunction with ship new construction.

In summarizing manpower factors, it is important to emphasize the different operational environments of naval and private shipyards. Naval shipyards, with their mission of maintaining rapid response capabilities to repair complex ships and weapon systems, must employ relatively stable and highly skilled work forces. Thus, skilled labor and the facilities must be on hand to respond to emergency situations and to adjust to program uncertainties.

Private shipyards operate in a different environment. First, they are profit motivated and could not remain in business without making a profit. This requirement and the instability of shipyard work require the private shipyards to implement different personnel policies than the naval shipyards. The private yards must be able to adjust their work forces relatively rapidly. In this respect, there are differences among the private yards based on workload performed. The highly volatile repair business causes very high layoff and rehire rates for labor in yards engaged primarily in repair work, whereas shipbuilding yards have significantly lower layoff and rehire rates. The duration of the workloads performed

by these yards is the main factor driving the layoff and rehire rates.

Thus, the naval and private shipyards operate in different environments under differing philosophies. A naval shipyard can have a guaranteed minimum workload and a stable career-motivated work force capable of responding to the immediate maintenance needs of the fleet. A private shipyard competes in the market place for work and adjusts its work force relatively quickly in relation to a varying workload. Both of these manpower philosophies appear to be appropriate to the differing environments.

D. SUMMARY

Naval shipyards are centrally managed and set up according to a prescribed organization. The private shipbuilding and repair industry comprises a wide variety of shipyards with almost as many different organizational structures as there are shipyards. Private shipyards owned by a parent firm are usually managed on a decentralized basis.

Naval shipyards are currently organized for repair work, thus if new construction were placed in these shipyards certain organizational changes would have to occur. One approach would be to integrate new construction functions with repair functions. A second approach would be to establish parallel functions within the shipyard departments. Private shipyards face similar problems in changing workloads, but most shipyards capable of new construction also perform repair. Thus, private shipyards are basically organized to perform both kinds of work.

Nuclear repair work in naval shipyards requires the addition of two organizational structures: the Radiological Control Office and the Nuclear Engineering Department. Private shipyards engaged in nuclear work also have these components although not necessarily under the same title.

The largest private shipyards in the United States compare favorably with the naval shipyards in their facilities; however, the majority of the private shipyards lack the quantity and quality of facilities found in naval shipyards. Graving docks are the standard drydocks in naval shipyards, while most private shipyards depend upon floating drydocks. If Navy ships continue to become progressively larger, there will be an increasing need for deeper drydocks in both naval and private shipyards.

In comparing new construction and repair functions, the same shops that support repair also support new construction, but in different degrees. The major differences are in the steel plate-handling and processing facilities required for new construction. New construction is a hull-erection process in which the material flow controls progress. Repair is a job-shop operation.

Ships would be built in naval shipyards in drydocks or on building ways. In private shipyards, they are built on building ways or in basins. Twenty-six private shipyards have some potential capability to build new ships as compared with four naval shipyards, Portsmouth, Philadelphia, Mare Island, and Puget Sound.

Naval shipyards performing nuclear work have special facilities adjacent to the drydock in which repairs to the nuclear propulsion plant are accomplished. These facilities provide access and minimize contamination problems. Similar facilities exist in nuclear-qualified private shipyards.

The shipbuilding and repair industry is a labor intensive industry in which there are shortages of skilled labor. Shipbuilding and repair employ basically the same skills, but with different distributions among trades. Shipbuilding requires more of the structural trades while repair demands more of the mechanical and electrical trades. The skilled labor in both naval and private shipyards is essentially the same and moves

from one sector to the other based on work and pay opportunities. The main movement has been from private shipyards to naval shipyards, where the pay is generally higher.

The private shipbuilding and repair industry experiences an annual turnover rate of about 50 percent as compared with about 8.5 percent in naval shipyards. Apprentice and other training programs are not adequate in the private sector.

Skilled workers engaged in nuclear repair in naval shipyards receive special training not only in their specific skill but also in safety and radiological control practices. A nuclear naval shipyard employs about 5-7 percent of its total work force in three nuclear-dedicated offices. The total number of additional employees, both direct and overhead, could not be estimated from the data made available to IDA. Data for the private shipyards were not made available to the IDA team.

New construction and repair characteristics and differences are summarized in Figure 22.

New Construction	Repair
Material flow controls work	Material flow controlled by work identified
Hull erection process and the installation of machinery, equipment, and fixtures	A removal, repair, and restoration process
A sequential process of each craft building on the work of those which preceded	A job-shop operation, start and stop process
Lends itself to orderly scheduling	Scheduling affected by mutual interferences, accesses, labor availability, and testing
More acceptable variations in skill levels	Less acceptable variations in skill levels
Emphasis on structural trades	Emphasis on mechanical/electrical trades
Utilizes building ways or basins	Needs deep drydocks
Small electrical power requirements until near end of construction	Large electrical power requirements
Extensive steel processing facilities	Limited steel processing facilities
Large assembly and material laydown areas	Small assembly and material laydown areas, partly covered
Large capacity weight handling equipment	Moderate capacity weight handling equipment except for unusual circumstances
Relatively clean working conditions	Relatively dirty and cramped working conditions
Nuclear work requires high skill level, but work is free of contaminated material	Nuclear work requires high skill level and special training to minimize exposure to contaminated material
Lower turnover and rehire rates	High turnover and rehire rates
Building period ranges from three to five years	Regular overhauls range from 5 to 12 months, with many repair jobs measured in a few days.

Figure 22. CHARACTERISTICS OF NEW CONSTRUCTION AND REPAIR

Chapter III

PLACING SHIP DEPOT MAINTENANCE WORKLOADS WITH COMMERCIAL CONTRACTORS AND NAVAL SHIPYARDS

The annual program for ship depot maintenance in naval and private shipyards is determined through a series of program-definition steps. The process starts with the development of the Navy Program Objectives Memorandum (POM), which is based upon planning and fiscal guidance issued by the Secretary of Defense.[1] The Navy, operating within fiscal constraints, conducts trade-off studies to allocate resources to the various programs contending for funds. In this environment, the gross maintenance requirements identified by the Navy always exceed the fiscal constraints.

Annex D to the Navy's POM submission to OSD describes the Ship Maintenance Program. This program provides the Navy's rationale for and the proposed funding of all ship maintenance financed by the Operations and Maintenance, Navy appropriation (O&MN) (including the O&MN Reserve appropriation). The Ship Maintenance Program comprises regular overhauls, scheduled restricted availabilities, restricted and technical availabilities, the installation of alterations and intermediate maintenance (tenders, repair ships and Fleet Maintenance Assistance Groups).

The O&MN funds appropriated for a given fiscal year for ship depot maintenance must be obligated within that fiscal

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[1]This process is part of the regular DoD PPB System with its prescribed review and adjustment procedures involving many agencies, including OSD, OMB, and the Congress.

year or the obligation authority lapses. The estimated full cost of an overhaul is normally obligated upon induction of the ship into the shipyard; however, annual appropriation obligation authority places four important constraints on management of ship depot maintenance, as follows:

(1) If changes in overhaul schedules are required late in the fiscal year, very rapid adjustments must be made in those schedules to accommodate the changes. Often, ships must be inducted into the shipyards quickly so current year funds to accomplish the work can be obligated before the end of the fiscal year. This situation may cause some inefficient use of funds.

(2) New fiscal year funds cannot be obligated until after the start of the fiscal year. Thus, contracts with private shipyards for ships scheduled to commence overhaul in the first month of the fiscal year cannot be awarded far enough in advance so the contractor can hire additional labor and procure required materials in an orderly manner. Delays in hiring labor and securing materials may extend or delay the overhaul period and increase the cost of the overhaul.

(3) Annual obligation authority limitations prevent the Navy from entering into long-lead-time contracts with private shipyards. Such contracts could offer incentives to the private contractors to hire and train skilled labor and invest in additional facilities.

(4) The Navy is prohibited from including escalation provisions in budget estimates for the funding of ship overhauls in the O&MN appropriation.[1] This restriction results in under budgeting of the costs of ship overhauls during periods of inflation and, consequently, prevents the Navy from overhauling all ships programmed for a given fiscal year.

The processes and procedures involved in the planning and placing of the various types of ship maintenance in naval and private shipyards are discussed in this chapter. Specifically, the methods used to develop the fleet overhaul schedule, industrial work packages for overhauls, and naval shipyard workloads are reviewed. The disposition of unscheduled industrial work

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[1]Office of the President, Office of Management and Budget, Executive Circular A-11, *Preparation and Submission of Budget Estimates*, June 1975.

and the placement of ship work in private shipyards are also discussed. Before examining these subjects, a brief survey is made of the size of the Navy ship maintenance program.

A. BACKGROUND

The ship depot maintenance program (including alterations, but excluding conversions) has grown from an $807 million program in fiscal year 1970 to almost $1.4 billion in fiscal year 1974. There has been considerable pressure to place a specified percentage of the total Navy repair work in the private sector. Top management officials from private shipyards and the President of the Shipbuilders Council of America have stated that their goal is to have 50 percent of Navy repair work done in private shipyards.[1]

Various government policy directives have required that a certain percentage of ship work be placed in private shipyards. A legislative amendment, enacted into law in 1964, required that at least 35 percent of the ship conversion, alteration, and repair funds be expended in private shipyards. Following a thorough study, the Department of Defense gained the concurrence of Congress to eliminate this requirement. In 1967, the Department of Defense issued instructions requiring DoD departments and agencies to assign, as a general rule, at least 30 percent of the total depot level workload required for mission-essential equipment to private industry.[2] In fiscal year 1974, Congress placed a floor under the amount of funds to be expended in each sector (private and public) for the overhaul

[1]U.S. Congress, House, Committee on Armed Services, Seapower Subcommittee, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part II, pp. 648-49. In the FY 1976 budget hearings, the Shipbuilders Council supported the Navy maintenance program without requesting a percentage of the work to be performed in private shipyards.

[2]*Current Status of Shipyards, op. cit.*, Part I, p. 12.

and repair of ships. As a result, nearly 30 percent of the Navy's repair and alteration work for FY 1974 was assigned to private shipyards. For fiscal year 1975, Congress placed a ceiling on the amount of funds available for the performance of alterations, overhaul, and repair of naval vessels in naval shipyards. This ceiling had the effect of causing the Navy to expend at least 27.4 percent of the funds available for alteration, overhaul, and repair of naval vessels in private shipyards.

Table 22 portrays the historical record of the percentages of shipwork allocated to private shipyards. Since fiscal year 1968, private shipyards have received 100 percent of new construction, over 50 percent of the conversion, and about 27 percent of the repair and alteration work. Figure 23 displays the percentage split between naval and private shipyards based on dollar value for conversion, alteration, and repair. This figure shows that the private sector's share since fiscal year 1965 has been greater than 30 percent.

The Navy has opposed the requirement that a mandatory percentage of repair work be allocated to private shipyards. One of the reasons has been the limited capabilities of many private shipyards to perform Navy work adequately, particularly complex ship overhauls. Figure 24 categorizes private shipyards in terms of capabilities to perform Navy ship overhauls and emphasizes the small number of private shipyards that can perform overhauls of combatants.

During the 1974 House Seapower Subcommittee hearings on the *Current Status of Shipyards*, persons associated with the private shipyard industry stated specific objections and complaints regarding their business relationships with the Navy.[1] Even though most of the criticisms were stated in terms of new construction, comments made in regard to the areas that are

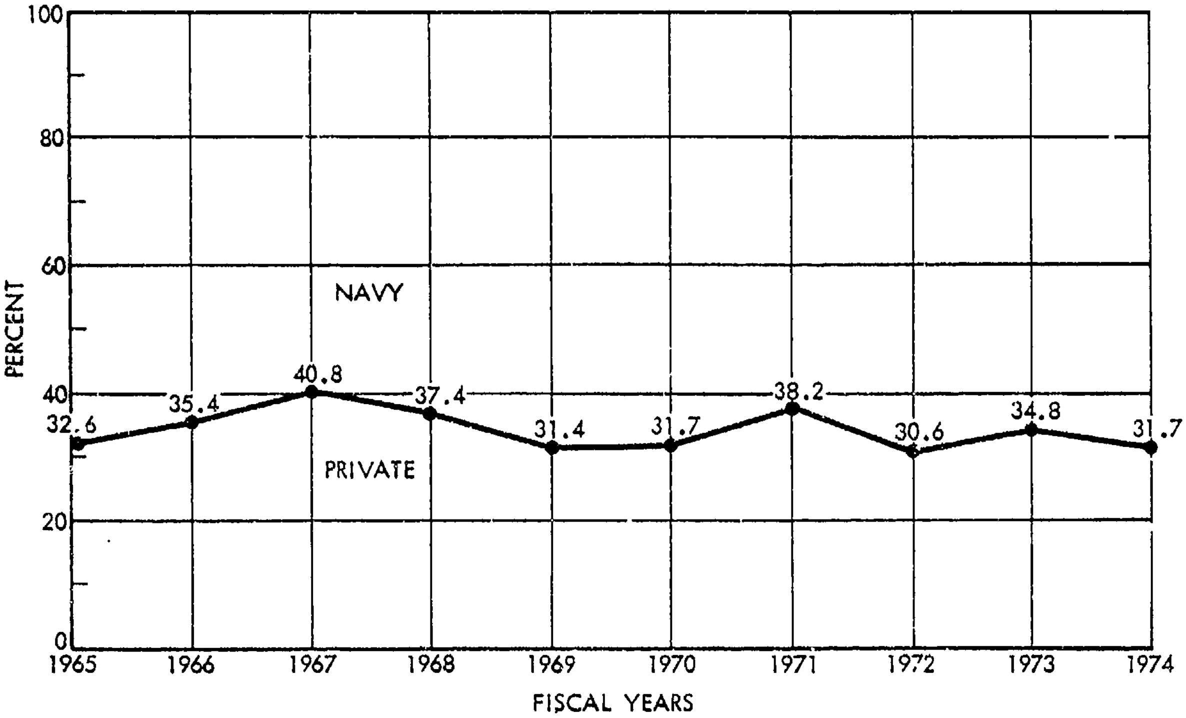
[1] *Current Status of Shipyards, op.cit.*, Part II.

Table 22. SHIPWORK ALLOCATIONS TO PRIVATE SHIPYARDS--
REPAIR/ALTERATIONS, CONVERSION,
AND NEW CONSTRUCTION, 1953-75

(Percentages)

Year	Repairs and Alterations	Conversion	New Construction	Total
1953	09.8	--	54.2	32.7
1954	16.3	--	100.0	56.1
1955	23.0	--	56.5	40.4
1956	20.8	04.5	68.9	51.1
1957	19.2	32.1	64.8	50.7
1958	18.8	--	80.9	62.0
1959	16.1	11.0	74.4	57.6
1960	15.3	11.2	83.3	48.7
1961	18.7	--	75.5	61.7
1962	25.3	13.6	67.7	56.6
1963	31.2	39.2	87.3	71.7
1964	32.4	27.4	81.2	62.1
1965	25.6	76.0	75.5	63.8
1966	40.6	11.1	84.5	65.4
1967	34.7	82.9	99.6	76.8
1968	28.3	62.1	100.0	55.3
1969	26.2	49.5	100.0	47.3
1970	26.5	44.2	100.0	74.3
1971	16.4	68.8	100.0	72.1
1972	18.9	53.3	100.0	71.1
1973	24.5	59.6	100.0	66.5
1974	30.7	46.6	100.0	78.4
1975*	29.9	52.9	100.0	78.5

Source: NAVSEA Letter, *NAVSEA Point Paper Updates* (0712:AGP), Serial 402, 23 April 1975.



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Source: U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part I, p. 11.

Figure 23. NAVAL-PRIVATE SHIPYARD CONVERSION, ALTERATION, AND REPAIR SPLIT
(Percentage distribution based on $ value)

listed below were broad enough to apply also to the accomplishment of depot maintenance workloads.

(1) Lack of a stable market.

(2) Lack of continuity in position of Navy personnel who had contract administration responsibilities.

(3) Lack of use of discretionary authority by local Navy officials.

(4) Adversary relationship between contractors and the government.

(5) Complex jobs not directed to the best qualified and proven shipbuilders.

These private shipbuilders' comments and opinions are discussed in Chapter VII.

- 188 Holders of master ship repair contracts
- 24 Of these have physical plant to perform complete regular overhaul (ammunition ship or larger)
- 21 Have physical plant necessary for overhaul of complex combatants (such as Forrest Sherman class destroyer)
- 7 Of the 21 have sufficient current employment and specialized trades for complex combatant overhauls
- 3 Licensed and qualified for nuclear ship repair and overhaul

Source: NAVSEA Industrial Activity Work and Resources Planning Division

Figure 24. PRIVATE SHIPYARD FACILITIES

The IDA team visited several private shipyards that either are or have been engaged in building and repairing Navy ships. Top management officials in some of these yards said that Navy work is the most desirable type of ship repair work. Navy ship repairs provide steady work for six months or more, yet the overhaul durations are short enough for the private shipyard operator to be able to predict costs with a relatively high degree of confidence. Because of the long lead times associated with the procurement of some material, the Navy has procured some material and provided it to the private shipyards as government-furnished material. The Navy generally prefers material, other than that furnished by the government as part of an alteration, be provided by the private shipyard contracting for the repair work. Thus, as lead times for material ease, more material procurement is being shifted back to the private contractor.

Navy ship overhauls are unique in ship repair in that there is not comparable volume and duration of work in commercial ship repair. Commercial ship operators are in business to make a

profit, thus commercial ships are taken out of service only long enough to make required repairs and to comply with the requirements of regulatory agencies. On the other hand, Navy ships are usually more complex vessels and have different maintenance standards and requirements than those that apply to commercial ships.

B. OVERHAUL SCHEDULING

The naval ship overhaul planning cycle starts at the beginning of the calendar year concurrent with the POM development. An overhaul schedule, together with related funding requirements is submitted in the POM and in the Navy budget. The process starts with a review of the existing overhaul schedules for the Atlantic and Pacific fleets. These schedules are published annually by the Chief of Naval Operations as OPNAV Instructions in the 4710.29 and 4710.30 series and are updated monthly, or more frequently as changes occur.[1] The overhaul schedules are normally changed by the Material Readiness Division (OP-43).[2]

The fleet overhaul schedules are predicated upon an established duration and interval between regular shipyard overhauls for all types of ships in the Navy.[3] Within some

[1]The use of the term "overhaul schedule" in the cited OPNAV Instruction is somewhat of a misnomer. These Instructions also display the schedules for selected restricted availabilities, post shakedown availabilities, inactivations, and conversions. Although the discussion of the development of these schedules uses the term "overhaul schedule," it includes all of the forms of depot maintenance scheduled in the OPNAV Instruction.

[2]Changes in the overhaul schedule can result from the review process relating to the Navy budget. OSD, OMB and Congress review and may change the funding requested by the Navy to overhaul its ships. Changes in funding resulting from any of these reviews are reflected in adjustments to the overhaul schedule.

[3]Duration and intervals between regular shipyard overhauls are published in OPNAV Instruction 4700.7E, Enclosure (4), Tab B.

types of ships, the duration and interval are established by class. The overhaul schedule displays by fiscal year the ships (by hull number) that are scheduled for overhaul, based on the established duration and interval. For example, a ship with an overhaul duration of five months and an interval of 48 months that completed overhaul in February 1975 would be scheduled to commence its next overhaul in 48 months (February 1979) or as soon thereafter as funds and industrial capacity permit. This ship should complete its overhaul in July 1979 (five months duration).

The overhaul schedule spans a seven-year period, which is divided into two time frames. The schedule during the first four years displays ships by hull number, the overhauling yard or SUPSHIP, if going to the private sector for overhaul, and the duration dates of the overhaul. These four years represent, in budget terms, the prior year, the current year, the budget year, and the budget year plus one. The last three years in the seven-year period (budget years plus two through four) or outyears display the ships by hull number and the fiscal year in which overhaul is scheduled.

The development of the overhaul schedule involves the interaction of various divisions within the OPNAV Staff, NAVSEA, the fleets, and the type commanders. The sequence of events in the development of the overhaul schedule is set forth in OPNAV Instruction 4700.7E. The cycle is portrayed in Figure 25. The ensuing discussion will cover these events and identify the interactions that take place. The discussion centers on the overhaul schedule for the budget year and the budget year plus one.

The General Planning and Programming Division (OP-90) in the Office of the Chief of Naval Operations develops information on force strength, current and projected status of all ships, and new construction and conversions authorized. The Material Readiness Division (OP-43) translates this information into

Mid-January	Chief of Naval Operations provides Commander, Naval Sea Systems Command and Fleet Commanders-in-Chief information on force strength, current and projected status of all ships, including authorized future new construction and conversions, approved special shipwork programs, and guidance on formulation of overhaul schedules, including anticipated funding levels.
Mid-February	Commander, Naval Sea Systems Command provides Long-Range Planning Ship Overhaul requirements schedule for the five-year Program Objectives Memorandum (POM) planning period (including industrial assignments through the first two POM years) to the Fleet Commanders-in-Chief, copy to Chief of Naval Operations and copies of appropriate sections to Type Commanders.
Mid-March	Reviewing commands return copy of draft schedules to Naval Sea Systems Command with mark-up and supporting comments.
Mid-April	Chief of Naval Operations/Commander, Naval Sea Systems Command planning team visits Fleet Headquarters to resolve differences and assist in final development of ship overhaul schedule and designation of complex overhauls.
Mid-May	Commander, Naval Sea Systems Command submits final draft of the five-year ship overhaul schedule to the Chief of Naval Operations.
Mid-June	Chief of Naval Operations publishes ship Overhaul Schedule, identifying those ships to be complex overhauls.

Source: Extracted from OPNAV Instruction 4700.7E.

Figure 25. CYCLE OF EVENTS IN THE DEVELOPMENT OF OVERHAUL SCHEDULES

changes to the existing fleet overhaul schedule. For example, a ship may be designated to be stricken from the active fleet at a future date, e.g., two years hence.[1] A change in the overhaul schedule would recognize this program action and indicate that this ship is no longer scheduled for an overhaul.

The OPNAV Fiscal Management Division (OP-92) and the Systems Analysis Division (OP-96) work with the Material Readiness Division (OP-43) to estimate the fiscal requirements for the overhauls appearing in the schedule. A dollar fiscal control total is determined for ship maintenance funded in the Operations and Maintenance, Navy appropriation. During this process, pricing is based upon average unit prices derived from latest experienced overhaul costs.[2] The latter may have a lag time of six months or more, depending upon when a ship of a particular class was last overhauled, but this is taken into account in deriving the new unit prices.

The Material Readiness Division sends NAVSEA its projected overhaul schedule for the budget year and the budget year plus one. NAVSEA converts the dollars estimated for the overhaul of each type of ship into production shop productive mandays. This conversion is accomplished by using an average manday rate,[3] multiplied by a factor that takes into consideration

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[1]The term used by the Navy for a ship that is removed from the active fleet on a permanent basis. The ship is "stricken" from the list of active ships in the fleet.

[2]Departure reports provided by naval shipyards and SUPSHIP are the basis for latest experienced cost data. Prior to submission of the Navy budget, the CNO requests the fleets to submit budgets for the overhaul of their ships. Budget estimates are no longer type or class average prices, but are estimated for each ship by hull number that appears in the budget year program. Pricing of each overhaul by hull number requires the type commander to be familar with the material condition of his ships. Two similar formats are used to derive the estimates. One format is used if the overhaul is scheduled for a naval shipyard and another if the overhaul is scheduled for the private sector.

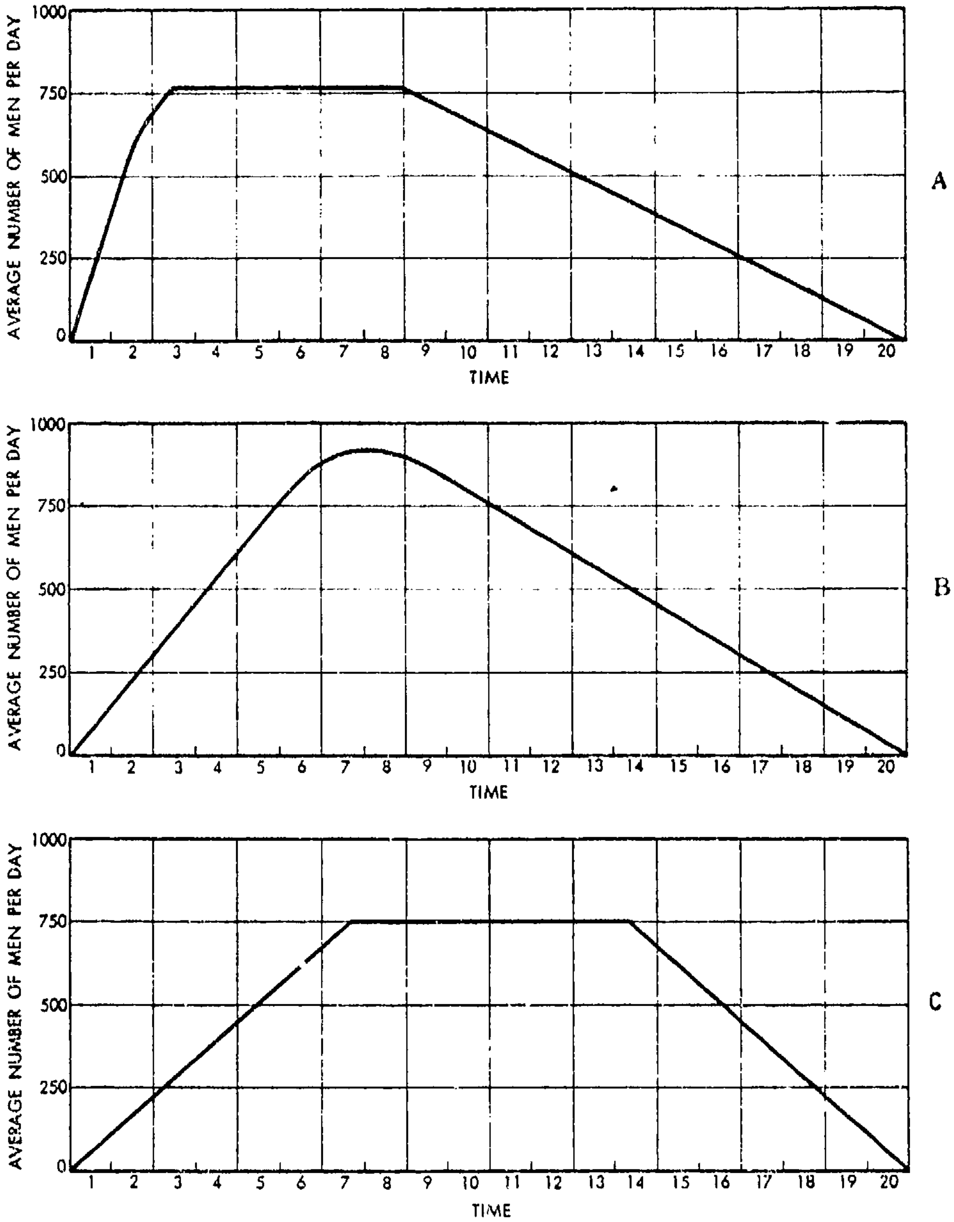
[3]The average manday rate is the average for the eight naval shipyards and includes an average direct labor cost and an average applied overhead rate.

the type of ship and the work to be done. This product is divided into the estimated cost of the overhaul to yield the production shop productive mandays required. Finally, NAVSEA places the production shop productive mandays into a computer program to workload the shipyards. The computer program contains drydock, facilities, and production shop productive manday information for each naval shipyard, as well as information on the special capabilities of the individual shipyards.

NAVSEA has developed shop productive manday distribution curves that show how each type of ship will be manned to accomplish the necessary work. More than one curve is available for a given type of ship. The selection of a curve depends upon such factors as the type of availability, the size of the work package, and manpower availability. The appropriate curve for each ship is selected to distribute the production shop productive mandays required for each ship's availability. Figure 26 shows three examples of these curves. The curves distribute manpower on the basis of 20 segments of time. Ship's workload data are entered in the computer in priority order. Carriers are followed first by SSBNs and SSNs, and then by the rest of the ships in the program. This initial computer run produces a tentative schedule and workload for each naval shipyard. Part of the computer printout is a chart showing, for each naval shipyard, the production shop productive mandays used versus available mandays over time. This chart readily identifies the peaks and valleys, and NAVSEA refines the schedule to smooth out the peaks and valleys that appear in the initial run. This part of the overhaul scheduling process takes place in the February-March time frame.

During this same time frame, NAVSEA reviews the assignment of ship overhauls to the private sector to provide about 30 percent of the maintenance work for private shipyards.[1] The

[1]As discussed earlier, the 70-30 split is a (continued on page 134)



Note: The curves in these diagrams are applicable to the following types of ships for:

A = Regular overhaul: DE, DEG, DLG, DDG, and DD

B = Regular overhaul: DLG, DEG, AGDE and DE

C = Fitting out: DLGN, DLG, DE, ASR; Restricted availability: CVA, CV

Source: NAVSEA Long Range Planning Branch

Figure 26. TYPICAL MANPOWER DISTRIBUTION CURVES

70-30 split of ship maintenance between naval and private shipyards is monitored continually, and ship assignments are adjusted as needed to meet changes in the overhaul schedule.

After NAVSEA has refined the overhaul schedule to produce the proper split and an acceptable level and balance of workloads, the schedule is sent to the fleets with appropriate sections to the type commanders for comment. The type commanders consider operational commitments, home-port policy,[1] material condition, and alterations desired on each ship. Refueling of nuclear-powered ships is also considered. After weighing these factors, the type commanders mark up the overhaul schedule with their comments and return it via the fleet commander to NAVSEA. This review and markup is normally accomplished in March or April.

NAVSEA places the information from the marked-up schedules into the computer. The result is a workload schedule for the shipyards with many peaks and valleys, which NAVSEA levels by adjusting individual ship overhauls, while attempting to meet as many of the fleet and type commanders' desires as possible.

In April or early May, a team representing the CNO and NAVSEA visits the fleet and type commanders to resolve schedule differences and develop an agreed overhaul schedule that can be accomplished within naval shipyard facilities and manpower constraints. The actual duration of the overhaul is a function of the amount of work on the ship authorized by the type commander and the maximum number of men per day that can be productively assigned to a ship to accomplish the work. The

(cont'd) primary consideration in Navy depot workload scheduling. Amphibious ships and auxiliary type ships are generally assigned to the private sector. Naval reserve training ships also may be assigned to private shipyards. Combatant ships are normally assigned to naval shipyards.

[1]The CNO home-port policy is to maintain crew morale by overhauling as many ships in or as near as possible to home port.

length of time for which the fleet or type commander assigns a ship to overhaul can be a limiting factor in determining how much work can be accomplished. Most of the schedule negotiations are between the representatives of the type commander and NAVSEA. The CNO representative ensures that fund constraints are not exceeded within fiscal years and serves as the final decision-maker if an agreement cannot be reached. As stated earlier, this process is concerned with the budget year and the succeeding year. Thus, the overhaul planning process that was completed between January and June 1975 was for fiscal years 1977 (budget year) and 1978 (budget year plus one).

NAVSEA examines the agreed schedules and places the applicable workload data into the computer to produce a final draft of the overhaul schedule. This schedule, which is the expanded seven-year schedule that encompasses the prior fiscal year through the budget year plus four, is then submitted to the CNO for approval. The outyear schedules (budget year plus two through four) indicate only which ships are scheduled for overhaul sometime during the year. The CNO publishes the overhaul schedule in June and distributes it to all interested parties.

C. WORKLOADING NAVAL SHIPYARDS

NAVSEA uses the published overhaul schedule and workload information from other sources to produce a Productive Workload Forecast (PWF) for each naval shipyard for each of five fiscal years beginning with the budget year. These forecasts are distributed to the fleets, shipyards, and OPNAV to verify the overhaul schedule. They become the planning documents for refinements or adjustments of workload. The PWF is updated monthly; data for the past month are deleted and the data for a new twelfth month are added to portray continually the projected workload twelve months ahead. The bases for changes to the forecast are the Planned Workload Employment Report (PWER)

submitted monthly by each naval shipyard, the monthly financial statement of each fleet, and changes to the overhaul schedule.[1]

The PWER contains actual data for the month reported and projects for nine months the Production Department's planned manning in men-per-day for each ship or other work assigned. Also reported are overtime and overhead planned in the production shops to support the productive work force, estimated absences, and actual total shipyard employment for the month reported and projections for the succeeding nine months.

The monthly financial statement of the fleet reflects the changes in funding allocated to each ship. Changes in dollars represent changes in mandays, hence a change in the workload forecast. The request for changes in overhaul schedule may originate with the type commander via the fleet commander, the shipyard, or in OPNAV. All of these factors enter into each month's update of the PWF.

Thus far, the discussion of the PWF has been primarily in relation to the ship overhaul schedule. All types of work undertaken by the Production Department and the required manning to perform the work are projected in the PWF. In addition to the workload generated by the ship overhaul schedule, naval shipyards perform research and development, equipment refit and restoration, test equipment and standards calibration, miscellaneous manufacturing, Military Assistance Program work and miscellaneous military support.[2] The manpower requirements for this work are incorporated into the PWF.

NAVSEA obtains budget-year estimates from the logistic managers and program sponsors for the above kinds of

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[1]The PWER is submitted in accordance with NAVSHIPS Instruction 12280.6B of 3 September 1971.

[2]A breakdown by cost and percentage of total cost of the work performed in the eight naval shipyards from 1960 through 1974 is provided in Appendix B.

ship-related and non-ship work.[1] NAVSEA then converts the dollars in these funding plans to productive shop mandays by applying productive manday factors. The manning rates for categories of work (such as the unscheduled restricted/technical availabilities, research and development, and equipment restoration) are frequently level of effort (straight line). For example, the PWF of 30 September 1974 for the Charleston Naval Shipyard showed the following projections: 200 men per day for restricted availabilities and miscellaneous shipwork, 250 men per day for other ship support work, and 7 men per day for military support. This form of projection is typical for these types of work. In other cases, the manning rates are negotiated to meet the customer's needs.

The total average men-per-day (production shop productive) allocated for all types of work assigned to a shipyard are displayed on a graph in the PWF. This graph provides a capsule view of the workload by month in relation to the available productive shop mandays. NAVSEA allocates the workload leaving minor peaks and valleys in each naval shipyard's workload forecast. Individual shipyards are expected to manage these fluctuations by scheduling and through the application of overtime.

In the workloading process, NAVSEA interacts with the potential customers of its shipyards and attempts to distribute and balance the workload while satisfying the customers. This requires careful consideration of various factors, such as the following:

(1) The carryover of workload from the previous fiscal year.

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[1]The logistic managers and program sponsors are Navy officials who manage and administer various programs for the NAVSEA, Naval Electronics Systems Command, Ship Parts Control Center, Naval Ship Research and Development Center, Inactive Ships Facility, and other naval activities and government agencies.

(2) The Navy's home-port policy.

(3) The facilities at each naval shipyard.

(4) The productive work force available in each naval shipyard. (Personnel ceilings may limit the size of the work force.)

(5) The trade balance within individual shipyards.

(6) The special capabilities of individual shipyards and past performance.

(7) The naval/private workload distribution policy.

(8) The tentative availability dates.

(9) The characteristic manning distribution for various types/classes of ships.

(10) The need for uniform workload distribution.

(11) The inputs from the shipyards concerning specific workload and manning problems.

After all factors have been considered, decisions made, and the PWF published and distributed, the shipyards are responsible for executing the workload plan. The shipyard negotiates with its customers for work packages, including the cost and time period for accomplishment. These negotiations may affect the published overhaul schedule and necessitate a request for change in the schedule. The CNO has delegated to the fleet commanders the authority to make minor changes in the overhaul schedules.

For regular overhauls and selected restricted availabilities, the fleet commanders can delay or advance both scheduled starting and completion dates up to five weeks provided the naval shipyard commander or SUPSHIP concurs. The fleet commanders can further delegate this authority to the type commanders. The modified starting dates must be in the same fiscal year as the original dates. Availabilities may be terminated early at the discretion of the fleet commanders.

D. SCHEDULED INDUSTRIAL WORK PACKAGE DEVELOPMENT

The accomplishment of work that is projected in the PWF begins with the identification of a work package. This section discusses the development of an industrial work package incident to a ship's overhaul. For the past twenty-five to thirty years, the basis for identifying work to be accomplished during an overhaul has been work requests orginated by the ship's force.

The ship's force traditionally used as a source for preparing work requests a manually maintained Machinery History and Current Ship's Maintenance Project (CSMP). These were series of large binders showing the history of each piece of machinery and equipment aboard ship and identifying any deferred maintenance.[1] The ship's force prepared work requests based primarily on entries in the CSMP, placed them in priority order, and submitted them through the chain of command to the type commander for screening and approval. Added to this repair package were the alterations that were approved and funded by NAVSEA's predecessor organizations and the type commander. The naval shipyard took the approved work requests and alterations and issued job orders to its shops for the accomplishment of the work.

The CSMP is still one of the basic inputs into the industrial work package, but the Navy has augmented it with other data sources and automated the process to make it more responsive.[2] The change has resulted from the rapid increase in the complexity of equipment and machinery aboard ships and shortages of skilled personnel. Personnel shortages have been

[1]Deferred maintenance is maintenance that, for various reasons, cannot be completed at the time it is identified, e.g., it is beyond the capability of the ship's force, cannot be accomplished while the ship is operating, or the parts or material required for the maintenance action are not available.

[2]The reports of the Boards of Inspection and Survey, the reports of other material and administrative inspections, and casualty reports all provide sources for initiating work requests. These sources may be fed into the CMSP or be adjuncts to it.

especially acute in the engineering ratings, in the E-5 through E-9 rates.[1]

The Navy recognized that as ships became more complex earlier planning and engineering were needed. This recognition resulted in the establishment in 1966 of the PERA program--Planning and Engineering for Repairs and Alterations.[2] The PERA program was designed to improve the advance planning, integration, and control procedures associated with the planning and engineering functions for the repairs and alterations required during the overhaul of ships. The first PERA office was established in March 1967. There are currently five PERA offices, each concerned with designated type(s) of ships.

PERA Title	Ship Types	Location
PERA (SS)	Submarines	Portsmouth Naval Shipyard
PERA (CV)	Aircraft carriers and other aviation-type ships	Puget Sound Naval Shipyard
PERA (CRUDES)	Cruisers/destroyers	Philadelphia Naval Shipyard
PERA (CSS)	Combatant support ships	NAVSEA Industrial Support Office, San Francisco
PERA (ASC)	Amphibious ships and craft	Norfolk Naval Shipyard

The five PERA offices, operating as extensions of NAVSEA's Ship Logistic Divisions, integrate the requirements of the various systems and type commands and manage the planning and engineering efforts for overhauls of assigned ship types and for vital interrelated programs pertaining thereto. Using ship modernization planning documents, the PERAs assist the ship logistic managers and type commanders in the development of class modernization and maintenance packages for assigned

[1]A rating is an identification of individual skills, e.g., engineman or electronics technician, and a rate is the pay grade within the rating.

[2]NAVSHIPS Instruction 5450.179 promulgates the policy and procedures concerning the management and operations of the PERA offices. NAVSHIPS Instruction 5450.180 details the procedures and interfaces for overhaul planning by a PERA office.

ships. They develop a complete and integrated ship overhaul planning work package that is fully usable by an overhauling activity with minimum translation and minimum additional planning. Normally, this work package is developed in conjunction with the overhauling naval shipyard or a SUPSHIP for private sector overhauls. Shipyard planners and estimators, however, still must perform detailed planning of each job, taking into consideration the assets available at the particular shipyard, and prepare final estimates of the cost to perform the work. The work package is subject to the final approval of the cognizant parties,[1] i.e., NAVSEA ship logistic managers[2] for the alteration package, and the type commander for the repair package. This package is developed within the constraints imposed by these cognizant parties.

Based on this description of the PERA's role in the advance planning process, the discussion that follows concentrates on the manner in which an industrial work package is developed. Figure 27 presents a capsule view of the work package development. Four inputs enter into the total work required. One is a repair package based on the CSMP and a Preoverhaul Test and Inspection (POT&I) Report.[3] Added to the repair package are three types of alterations--type commander authorized and funded alterations, general ship alterations authorized and funded by NAVSEA, and special ordnance alterations also authorized and funded by NAVSEA.

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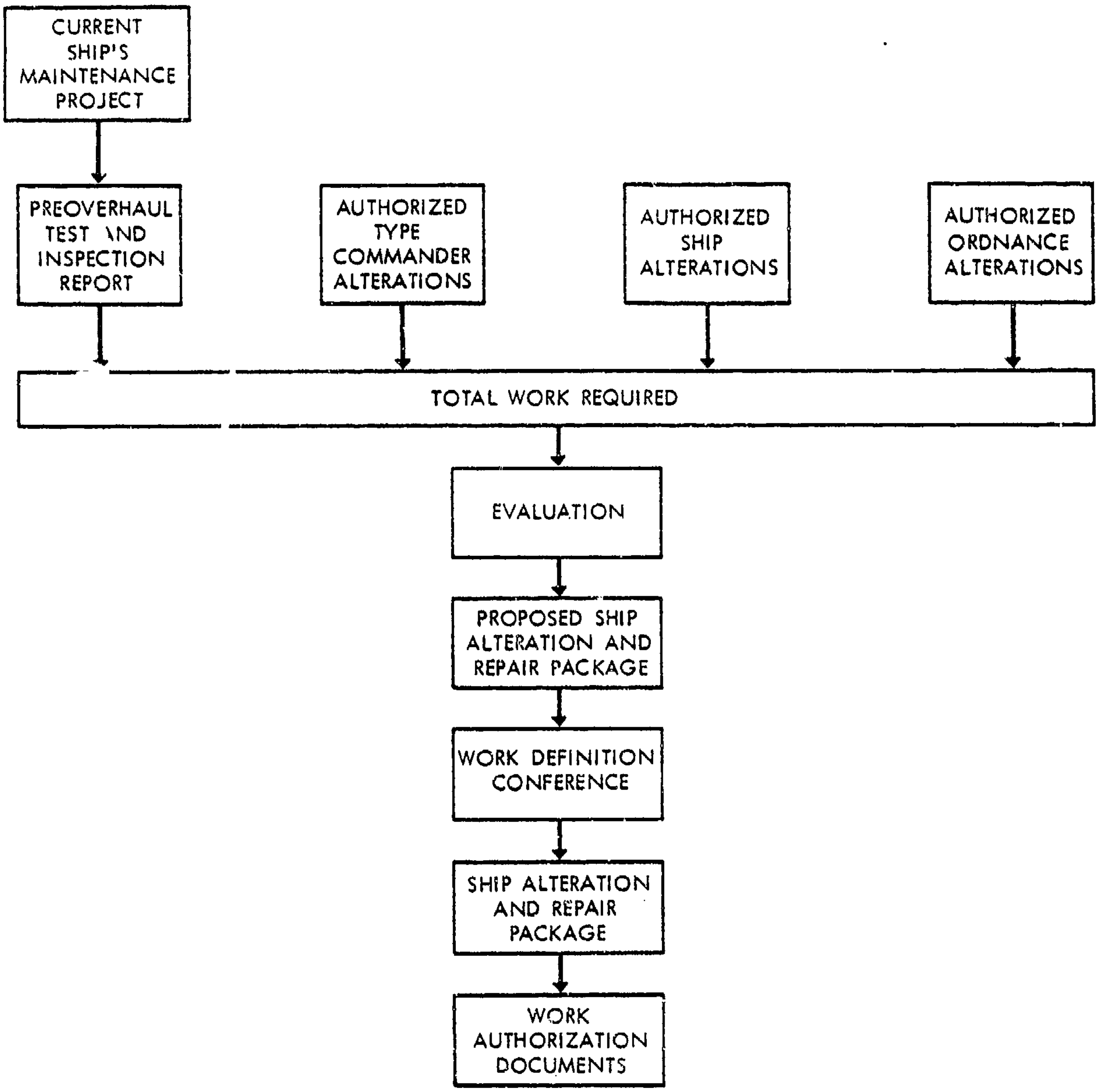
[1]Based on OPNAV Instruction 4700.7E.

[2]Ship logistic managers are directorates in the NAVSEA that have cognizance over a type or types of ships, e.g., Submarine Directorate, Escort and Cruiser Directorate, Amphibious and Auxiliary Ship Directorate, and Aircraft Carrier Directorate. The ship logistic manager is also referred to as the type desk.

[3]A POT&I is made by a team from a shipyard or a private engineering firm under contract to determine the material condition of the ship and recommend repairs.



Source: Maintenance Officer, Surface Force, Atlantic Fleet.

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Figure 27. DEVELOPMENT OF THE INDUSTRIAL WORK PACKAGE

The total work required is evaluated and the interrelationships among repairs and alterations identified.[1] Through this process, the proposed Ship Alteration and Repair Package (SARP)--a single source document that integrates all customer work (repair and alterations)--is developed. A work definition conference is held involving the NAVSEA ship logistic manager, the PERA, type commander, the overhaul activity, and the ship. All work items are reviewed and decisions made as to whether the work will be accomplished or deferred. If the work is to be accomplished, it may be assigned to the overhauling activity, an intermediate maintenance activity, or to the ship. The last two activities are commonly referred to as forces afloat. Intermediate maintenance activities are frequently represented at these conferences so the conferees may understand, clearly, the ability of these activities to perform work to be referred to them.

The type commander authorizes the repair work to be accomplished within the funds available for the overhaul and places the work items in priority order. This process involves trade-offs between industrial and forces afloat work packages.

Based on the decisions made during the work definition conference, a final SARP is produced. This document is the authorizing vehicle between the customer and the overhaul activity. A naval shipyard uses the SARP as the basis for writing job orders, and SUPSHIP uses it for writing specifications leading to a solicitation for the work assigned to the private sector.

1. Naval Shipyards

This section describes in greater detail the important features of advance planning and the development of an

[1]The evaluation and interrelationships identification may be performed by a PERA, a naval shipyard, or a private engineering firm under contract.

industrial work package for work to be performed in a naval shipyard. The planning for an overhaul can be divided into three segments:

(1) Planning of the repair work to be performed by the overhauling activity.

(2) Alteration planning.

(3) Planning the repair work to be accomplished by the ship's force.

These planning processes begin about 360 days prior to the commencement of the overhaul, which will be referred to as "A-day." All events leading up to A-day will be time phased in "A" minus so many days (e.g., A-360). A-day is determined from the published overhaul schedule.

The advance planning process starts about A-360 with the issuance of advance planning letters. NAVSEA (the appropriate ship logistics manager) issues an advance planning letter that (1) provides a tentative list of ship alterations to be accomplished, (2) authorizes a nominal amount of funding for advance planning for alterations by the planning yard and the overhaul activity, and (3) directs the appropriate PERA to plan and coordinate the overhaul.[1]

The PERA, in turn, prepares an advance planning letter that tasks the planning yard and the overhauling activity to perform certain functions according to an enclosed milestone schedule. The letter is quite detailed and forms and formats for various requirements and inspections are included with it.

The type commander also may issue an advance planning letter that may task or amplify previous tasking by the PERA to manage the planning and engineering for the repair and

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[1]The naval shipyard designated as the overhaul activity or yard and the planning yard are not necessarily the same shipyard. The planning yard is a naval shipyard that is responsible for maintaining the class plans and other selected data for certain classes of ships assigned to it.

type-commander-funded alterations work package.[1] This letter delineates the responsibilities of the ship's commanding officer and the overhauling activity. It also may include a list of routine overhaul items to be accomplished.

The above letters are normally issued in the order discussed. The times of issuance may vary because of the complexity of the overhaul and the administrative workload affecting the issuing activity.

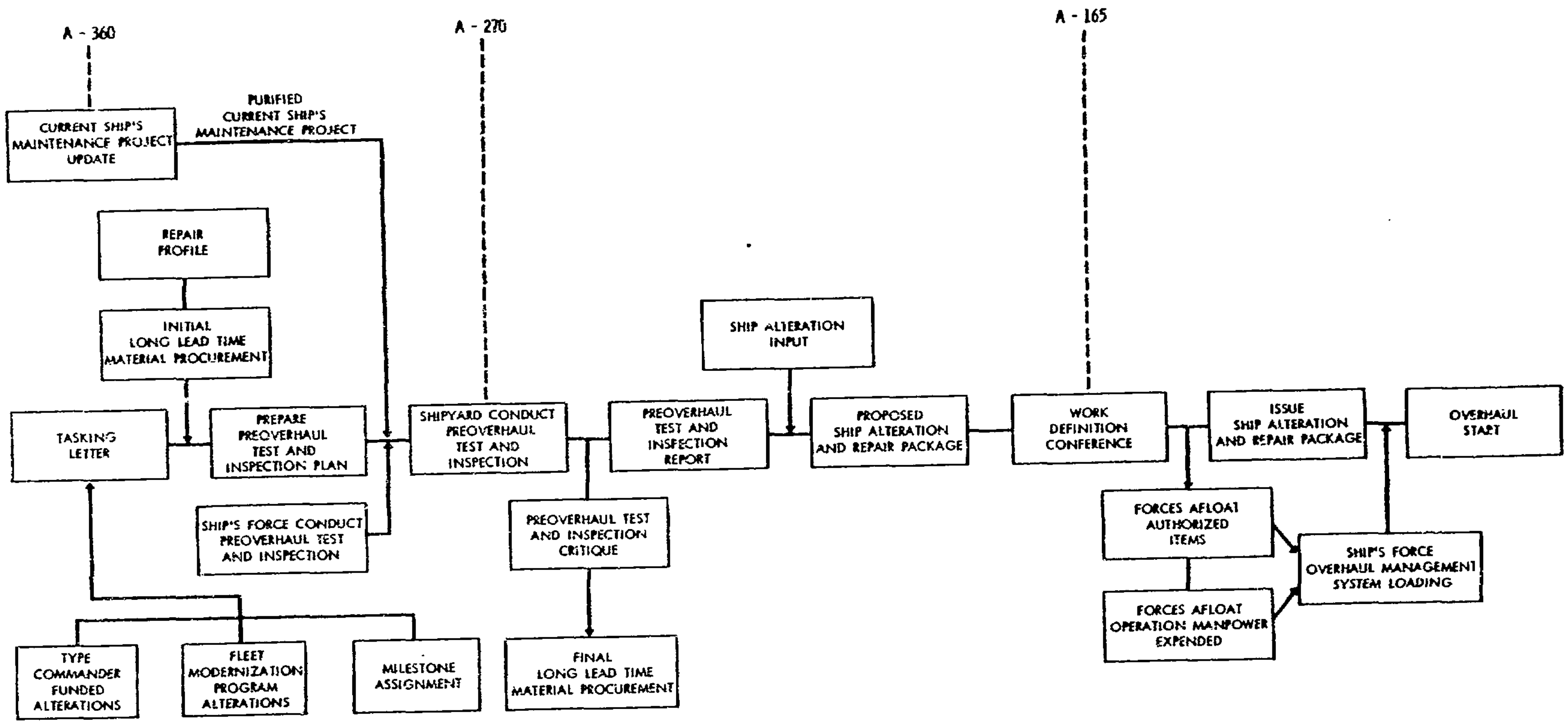
a. Planning for Shipyard Work

Figure 28 presents the advance repair planning segment of a total ship overhaul planning process. The times displayed on this figure are target times and may vary for many reasons. The timing of key events must be compatible with the ship's operating schedule. The schedule of key events and the details of how the events are accomplished vary among type commanders. This discussion, therefore, will be in terms of a typical advance planning schedule for surface ships (except aircraft carriers[2]) scheduled for overhaul in a naval shipyard.

At A-360, the ship's force begins an update or purification of its CSMP. This process involves reviewing each work item in the CSMP to determine if it is still valid (i.e., are conditions still the same, has the work been accomplished by another activity, and so on). The ship's force also prepares and holds its own preoverhaul test and inspection to uncover additional work items. The purified CSMP and the results of the

[1]Tasking of a PERA is normally performed by the task-originating activity submitting the task to the cognizant NAVSEA ship logistic manager, who determines if the task falls within the scope of the PERA charter and that the PERA has sufficient work force capacity to handle the task. Type commanders have authority (NAVSHIPS Instruction 5450.179) to task PERAs directly, but they must inform the cognizant NAVSEA ship logistic manager.

[2]Aircraft carriers are complex overhauls for which advance planning starts earlier than for the less complex overhauls described here.



Source: Maintenance Officer, Surface Force, Atlantic Fleet.

Figure 28. REPAIR PLANNING

preoverhaul test and inspection conducted by the ship's force are submitted to the PERA through the type commander.

The previous paragraph describes how the system is designed to function. In the real world many variations occur. The accuracy, completeness, and currency of the CSMP differ among ships since the quality of data is largely a function of the interest, motivation, and training of the ship's force. For this reason, the PERA may send a small team aboard ship to update the CSMP with ship's force assistance to insure that work identified for shipyard accomplishment is complete and accurate.

The PERA, during the early phases of the planning cycle, reviews the class repair profile and, based on these historical data, orders long-lead-time material (LLTM).[1] This event may be delayed if the type commander has not provided the necessary funding. The PERA also prepares a plan for the POT&I. This plan defines what is to be inspected aboard ship, how the inspection will be conducted, and who will perform the inspection.[2] The execution of the POT&I requires five-to-ten days in port plus one-to-three days at sea. The rather lengthy in-port period is needed because some of the machinery and equipment must be opened and partially disassembled to provide an accurate assessment of the existing conditions. Following the tests and inspections, but prior to the issuance of a report, a critique is held with the inspectors, PERA engineers, and the ship's force. A POT&I report stating the conditions found and the repairs recommended is then written. The report

[1]The repair profile is a system-oriented historical summary of the work normally accomplished on equipment and components aboard a particular class of ships. This profile displays the dollars and mandays previously required to perform the repairs.

[2]Normally, the overhauling naval shipyard would perform the inspection, assisted by PERA engineers. When the workload of the overhauling yard prevents it from making the inspection, another shipyard or a private engineering firm may be engaged to perform the inspection.

blends the results of the in-port and at-sea phases by ship's systems. Based on the conditions found, the final LLTM procurement action is taken about A-270.

The work identified in the POT&I report together with the alterations authorized (see below) are combined into the SARP. About two weeks prior to the work definition conference, which is scheduled at A-165, the overhauling shipyard should have completed preliminary cost estimates on each work item in the SARP.[1] Once again, the participants in this conference are representatives from the NAVSEA, type commander, PERA, overhauling shipyard, the ship, and an intermediate maintenance activity, if available.

Prior to the work definition conference, the representative of the type commander develops a plan indicating how much he wishes to spend on the forthcoming overhaul and places all requested work in an order of priority. At the conference, each work item is discussed and a decision made by the type commander as to its disposition. The PERA acts as a technical adviser to the type commander during this conference. Work items may be placed in the following categories: (1) approved for shipyard accomplishment, (2) approved for intermediate maintenance activity accomplishment, (3) work to be performed by ship's force, (4) deferred work, and (5) work not authorized. A running total is maintained of the estimated costs for the work items approved for shipyard accomplishement. When the amount planned for the overhaul (including some predetermined amount for contingencies) is reached, the work approval for the shipyard stops. All outstanding work requested is placed in one of the four other categories. Almost invariably there are

[1]The overhaul yard has evaluated each work item and identified the interrelationships among work items and between work items and alterations. Shipyard planners and estimators estimate the manpower and material requirements for each job. Labor, material, and overhead rates are applied to these requirements to produce a total estimate.

more work items for accomplishment than there are available funds. Some bargaining is done by the ship, shipyard, and type commander, but the final approved total cost must remain within the planning figure.

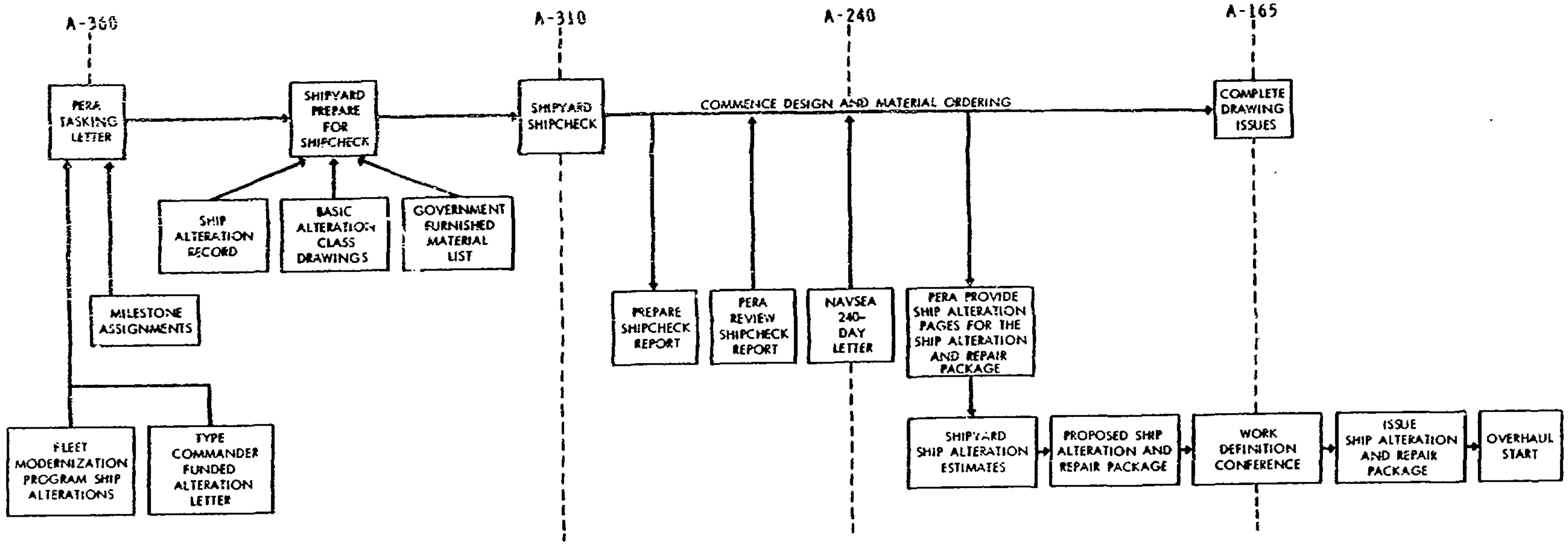
The decisions at the work definition conference permit the overhauling shipyard to conduct internal planning for the overhaul, e.g., design engineering, originating job orders, and ordering material. A final SARP is published by the PERA, tasked naval shipyard, or private engineering firm, as discussed earlier. This publication is the official authorizing document between the type commander and the shipyard.

b. Planning for Alterations

The second segment of advance planning, that for alterations, also begins about A-360, although some type commanders start advance planning for alterations at A-420 or earlier. (The process is depicted in Figure 29.) The type commander provides advance planning funds as soon as this planning process is initiated. The PERA reviews the published Fleet Modernization Program and initiates a dialogue with the ship logistics manager to determine which alterations will most likely be accomplished. The ship logistics manager consults with the CNO Material Readiness Division (OP-43) to determine changes in the Fleet Modernization Program for specific ships.

The PERA issues a tasking letter to the overhauling yard to commence advance planning on the tentative CNO-approved ship alterations.[1] A separate planning letter is issued to the yard for type-commander-funded alterations. Following

[1]The PERA, based upon consultation with the ship logistics manager, arrives at a list of ship alterations approved by the CNO that most likely will be funded by NAVSEA during the forthcoming overhaul. The overhauling yard is tasked by the PERA to commence advance planning for these alterations. The firm list of funded ship alterations is issued later by NAVSEA at A-240.



Source: Maintenance Officer, Surface Force, Atlantic Fleet.

Figure 29. SHIP ALTERATION PLANNING

receipt of a tasking letter, the shipyard starts preparations for the ship-check. The shipyard reviews the Ship Alteration Record to verify the applicability of the alterations and to assess the actions that must be initiated.[1] The overhauling yard may request from the planning yard the basic alteration class drawings.[2] These drawings, which provide basic alteration information about a class of ships, may have to be adapted to each particular ship of the class following a ship-check. Government-furnished equipment is identified and its issue status ascertained for each alteration. A ship-check is conducted by shipyard personnel who visit the ship to obtain a first-hand view of the conditions that will affect the initially proposed alterations. A ship-check report, issued to the PERA, indicates what changes are necessary to class drawings and what recommendations the yard has for the installation of an alteration. The report would indicate if an alteration has already been completed or partially completed.

The ship logistics manager issues the NAVSEA 240-day letter (at A-240) (formally the 180-day letter). This letter lists the ship alterations approved for accomplishment on a specific ship, together with a cost estimate for the installation. The PERA or the overhauling shipyard originates ship alteration pages for inclusion in the proposed SARP. The shipyard prepares an independent estimate of the cost of installing each alteration and performs the necessary design engineering to

[1]A Ship Alteration Record is a separate record for each ship alteration. It provides a brief description of the alteration, the ship class and hulls to which it applies, and the purpose; reference drawings; and describes what the alteration accomplishes and in general terms what is to be done. It includes a bill of materials with cognizant codes, weight and moment data, and the basic alteration class drawings to be developed.

[2]The planning yard develops basic alteration class drawings and updates selected record data and drawings. A file of drawings is maintained for each ship assigned to the planning yard.

modify class drawings to a specific hull.[1] The integration of the ship alteration pages with the repair work in the proposed SARP that is prepared for the work definition conference ends the separate planning processes for repair and ship alterations.

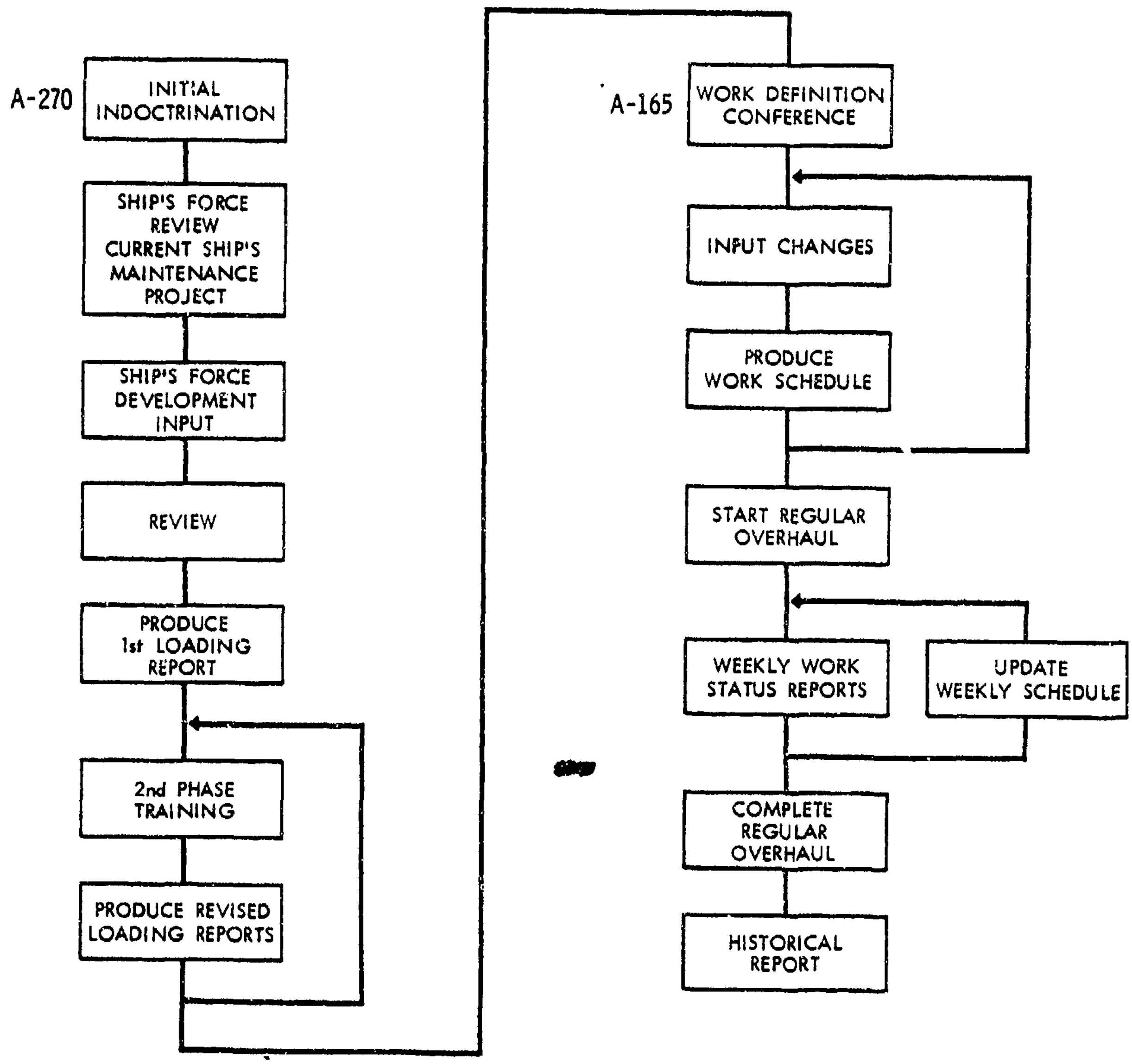
For overhauls of less than nine months duration, the NAVSEA ship logistics manager cancels --at A-90-- ship alterations for which special program material, essential incidental installation material, and design plans are not available, unless the procuring or design agent can assure that the required material or plans will be available at the start of the overhaul. For overhauls exceeding nine months duration, the material or plans must be available thirty days prior to actual date on which they are needed.

c. Planning for Ship's Force Work

The third and final segment of advance planning for overhaul is the ship's force overhaul management system (SFOMS). This system is an automated program that interfaces with the naval shipyard's management information system (MIS) on a computer terminal time-sharing basis. The PERAs are tasked by NAVSEA to maintain this SFOMS, train the ship's crew in its use, and install it aboard ship. Each ship's force job is divided into key operations and the manpower and material requirements are identified. These factors are entered into the computer to produce a work schedule that must interface with the overhaul yard's key events and milestones.[2] The schedule for the SFOMS is shown in Figure 30.

[1]Figure 29 shows that these drawings are completed at A-165, although in reality some drawings may not be completed until after the start of the overhaul.

[2]Detailed planning for the work the ship's force will accomplish during the overhaul is important because only about 20 percent of the total ship's force manhours are available for productive work. Military duties, annual leave, illness, training, formal schooling, and other miscellaneous activities consume most of the ship's force manhours. Source: Discussions with Atlantic Fleet Type Commanders' Maintenance Officers.



Source: Maintenance Officer, Surface Force, Atlantic Fleet.

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Figure 30. SHIP'S FORCE OVERHAUL MANAGEMENT SYSTEM

The initial indoctrination of the ship's force by a PERA team or a PERA representative assisted by a private contractor is conducted at about A-270. The ship's force reviews the CSMP if it has not already done so. The ship's force input is delivered, reviewed, and entered into the computer program to produce the first loading report, which identifies workload imbalances and shortages of manpower. A second phase of training for the ship's force is conducted. During and following this training, the ship's force reevaluates the manpower required to perform each job, the priority of each job, and other alternative means of having the work accomplished. Several of these iterations are performed until a balanced ship's force work schedule is produced.

About A-165, the previously discussed work definition conference is held. As indicated earlier, some of the work contained in the ship alteration and repair package will be referred to ship's force for accomplishment. These jobs are divided into key operations and the manpower and materials requirements are identified and entered into the computer program. This additional work causes another imbalance between workload and the manpower available to perform the work. The ship's force must reevaluate its workload and again perform iterations to match workload with manpower. Assistance from the shipyard may be required and some work deferred to achieve a workload balance. The SFOMS report is updated weekly during the overhaul and weekly work status reports are issued.

This discussion of advance planning in preparation for overhaul has been in the context of a naval shipyard overhaul. Since most of the ships overhauled in naval shipyards are combatant ships, the described advance planning process pertains mainly to these ships. The advance planning for ships overhauled in the private sector is examined below.

2. Private Shipyards

The advance planning for an overhaul scheduled for a private shipyard commences at A-360, as for a naval shipyard overhaul. The process is essentially the same as described for naval shipyards, although there are some variations. The main participants in the advance planning process for overhauls to be accomplished in the private sector are the PERA, NAVSEA ship logistic manager, type commander and representatives from SUPSHIP, the planning yard and from the ship. The principal difference is that the overhaul yard is not involved in the planning process until after the overhaul has been awarded to the private shipyard.

For combatant ships that are assigned for overhaul to private shipyards the advance planning and industrial work package development are essentially as described earlier for naval shipyards. The SUPSHIP uses the approved SARP to write specifications. A private engineering firm may be placed under contract to perform the ship-checks, conduct the POT&I, train the ship's force, and install the SFOMS. PERA and SUPSHIP personnel assist the private engineering firm in performing these functions over the time-phased advance planning schedule.

In OPNAV Instruction 4700.7E, milestones are established for bidding private shipyard overhauls and selected restricted availabilities.[1] These milestones are shown on Figure 31. The PERA uses the OPNAV-published milestones as a framework and develops a more detailed overhaul planning milestone chart. The SUPSHIP also develops a very detailed list of milestones Appendix L contains a sample PERA milestone chart and a SUPSHIP pre-planning check list for regular overhauls.

The advance planning milestones for an overhaul scheduled in a private shipyard are essentially the same as those

[1]This milestone schedule for bidding private shipyard overhauls became effective in July 1974. As of the date of this report, it is too early to evaluate the impact of this schedule on private shipyard overhauls.

Time Frame	Milestones
A-360	NAVSEA provide advance planning letter with initial funding for Shipalts based on FMP.
A-240	NAVSEA issue 240 day Shipalt letter with advance funding.
A-240	Material managers take supply action to provide Shipalt material.
A-240	PERA/Type Commander identify long-lead-time items for TYCOM Alts and repairs. TYCOM provide authorization.
A-235	TYCOM provide preliminary planning estimate based on SUPSHIP request.
A-230	SUPSHIP commence ordering LLT material identified by the PERA/TYCOM for TYCOM Alts and repairs.
A-230	SUPSHIP order all LLT material for NAVSEA authorized ALTs.
A-150	Ship provide advance work requests to SUPSHIP.
A-140	TYCOM/PERA provide screened advance work requests.
A-150 thru A-85	TYCOM provide screened supplementary repair work request. After A-85 only mandatory/emergent work requests will be accepted.
A-90	NAVSHIPS cancel Shipalts for which special program material, essential incidental installation material, and/or design plans are not available unless, at the A-90 day point, the procuring or design agent can assure that the required material or plans will be available by the start of the ship's availability or, in the case of overhauls scheduled to take more than 9 months to complete, that it will be available at least 30 days prior to actual need. Prior to cancellation of a Shipalt for lack of material or plans, NAVSEA will advise OPNAV (OP-43) of its intended action.
A-85	SUPSHIP request updated funds in amount to cover total estimate of overhaul package.
A-30	Award contract and advise all concerned of overhaul site.
A-Day	Start of the overhaul.

Source: OPNAV Instruction 4700.7E.

Figure 31. MILESTONES FOR BIDDING PRIVATE SHIPYARD OVERHAULS AND SELECTED RESTRICTED AVAILABILITIES

scheduled in a naval shipyard, from the first planning letter at A-360 through the work definition conference at A-165. A major difference is that LLTM is ordered by the SUPSHIP instead of the overhauling yard and NAVSEA validates the procurement of government-furnished equipment and material that are supplied as part of an alteration package. Another difference is that the SUPSHIP provides the cost estimates for the SARP in lieu of a naval shipyard.

From milestone A-165 forward, the advance planning actions differ significantly if the work is to be performed in a private, as opposed to a naval, shipyard. As mentioned earlier, the SUPSHIP converts the data contained in the SARP into specifications.[1] The completion milestone for specifications is A-85, and the invitation for bid is sent to private contractors at A-75. (These procedures are discussed later in this chapter.) Between these two milestones occurs the pre-arrival conference at which the specifications are reviewed and late changes are made.

A period of time is designated as the contractor inspection period, during which the contractors may go aboard ship to survey the work to be done. Ideally, this is also the time when the ship is in its home port. Sometimes the ship is unavailable and the bids must be submitted on the basis of written specifications, plans, and drawings. Contract award is scheduled fc A-30.[2] A final review of the SFOMS is made

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[1]Specifications detail, step-by-step, what repair work the private contractor is expected to perform. Since the private contractor bids on and performs only what is written in the specifications, the latter must be precise and complete. Specifications, drawings, blue prints, and other selected data comprise the bid package.

[2]Scheduling contract award at A-30 is a significant improvement over previous procedures under which contract awards could be made from a few days prior to start of the overhaul up to the start date itself. The 30-day lead time is still too short to permit the procurement of long-lead-time material for many overhauls. To overcome this deficiency the SUPSHIP identifies and orders long-lead-time material, which is then (continued on next page)

and a computer terminal installed prior to start of the overhaul.[1] The arrival conference is scheduled for the day the ship arrives in the private shipyard or, if possible, a few days earlier.

3. General

The advanced planning process for regular overhaul of Navy ships, whether conducted in naval or private shipyards, commences about a year prior to the start of an overhaul. As described earlier in this chapter, the milestones leading up to the SARP are the same, regardless of where the ship is overhauled. The major differences occur following the development of the SARP.

The SUPSHIP uses the SARP as a basis for writing very detailed specifications for each job. The private shipyard sees the specifications for the first time at A-75, when an invitation for bid is sent out. The private contractor has about forty days to visit the ship, if available, to survey the work requested and prepare a bid on the job. The lowest bid from a responsible contractor determines who receives the contract and becomes the fixed price for the overhaul, subject to change orders.

Bids are opened and a contract awarded about A-30 or later. This timing of the award gives the private contractor a month or less in which to order material, adjust his labor force, and complete detailed plans for the overhaul. Private contractor success under these conditions has varied. A number of factors

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(cont'd)furnished to the private contractor. Another factor that permits this short contract award lead time is that most private contractors use the specifications as written by SUPSHIP as their job orders, thus the time needed to originate internal documents is reduced.

[1]The computer terminal may be installed on the ship, if space is available, or in space provided in the shipyard.

enable private contractors to perform work successfully and at a profit under this system:

- Contractors enjoy considerable flexibility to hire and lay off labor on short notice.
- Long-lead-time material is usually furnished by the government.
- For many smaller contractors, an overhaul of a naval ship represents employment of most of the work force, and therefore, there is little integration required with other work.

In contrast with the private shipyard, a naval shipyard is involved in the planning process from the beginning and, in most cases, planners and estimators from a naval shipyard help prepare the SARP. Naval shipyard management knows before the advance planning starts that a particular ship will be overhauled in its yard. The SARP is used as the basis for writing job orders in the naval shipyard.

Job orders for naval shipyard work are written in more general terms than SUPSHIP-prepared specifications for private yards. These orders can be written in less specific terms for naval shipyard work since the shipyard employees have a good general understanding of terminology used in the Navy job orders to identify what work is to be accomplished. A naval shipyard planner, for example, can write a job to overhaul a piece of electronic equipment merely by stating "perform a class B overhaul." All persons involved are familiar with the requirements for a class B overhaul. Writing specifications for similar work to be performed by a private contractor requires that specific tasks be stated in detail since there is uncertainty whether a common understanding of Navy terms will exist. Also, terms must be completely clear since payments under the contract must be based on understandings of work to be done.

The naval shipyard is not required to provide its customers a fixed price for an overhaul until 50 percent of the work required in the overhaul has been accomplished. By this time,

all major required work should have been identified. These provisions indicate that even after a year of careful advance planning with naval shipyard personnel involved at every stage, the true condition of the ship and the total work to be accomplished are not known until equipment and machinery are disassembled and much of it removed to the shops. Yet, the contracting procedures for private shipyard overhauls require a private contractor to set a fixed price before the start of the overhaul based, at best, on limited observation of the ship and the written specifications and drawings provided by the SUPSHIP. Under these conditions it is safe to assume that a private contractor will not know the true condition of the ship any earlier than it would be known in a naval shipyard.

Private contractors have relied on change orders to recover the cost of additional required work that was not contemplated under the original bid. Often these change orders represent 20 percent to 50 percent of the value of the bid price. Apparently, contractors have been able to make a profit in the past under this system. It must be recognized, however, that the Navy, generally, has only contracted with private shipyards for surface ship overhauls on the less complex ships. Navy programs for the future will require that many of the more complex ships be overhauled in the private sector. Moreover, even in the recent past, inflation and high interest rates have reduced the opportunity for private contractors to make a profit on Navy repair work. The high costs of change orders are frequently disputed by the Navy, which results in a drawn-out negotiation process. To meet their cash needs, private contractors often must borrow money at high interest rates and, thereby, reduce their profit potential. This situation tends to lessen the desirability of Navy work and could affect the Navy's ability to have its overhaul programs accomplished in the future. This subject is discussed further in Chapter VII and a recommendation is made for improving the system.

E. UNSCHEDULED INDUSTRIAL WORK

Unscheduled industrial work is normally work of an emergency nature that cannot be deferred until the ship's next scheduled overhaul or scheduled restricted availability. This work is accomplished during a restricted availability, a technical availability, or as an emergency voyage repair, as specified by the cognizant type commander. Notification of unscheduled work is frequently relayed by telephone from the type commander to the shipyard or SUPSHIP.

A ship may be at sea, on its way into port, or already in port. When the ship is at sea, the work is planned and material ordered based on information provided by message from the ship. When the ship is in port, shipyard or SUPSHIP personnel board the ship to survey the work and initiate the necessary actions to start the repair. The ship's force prepares a work request for the repair that provides information the naval shipyard uses to prepare a job order or the SUPSHIP uses to write a specification. The paper work may be processed concurrently with work accomplishment or after the work is completed.

Type commanders have delegated authority to subordinates to approve emergency repair work within set limits. For instance, the Atlantic Fleet Submarine Type Commander has delegated authority to his squadron commanders and the Surface Force Type Commander has delegated authority to readiness assistance groups in ship home-port areas. In this discussion, the use of the term "type commander" means either the type commander or his designated representative.

Restricted availabilities normally require the ship to be in the shipyard for the accomplishment of the repair. Therefore, the type commander may authorize the accomplishment of non-urgent work concurrently with the emergency work. During a technical availability, the ship is normally not brought into the shipyard; the repair work is frequently accomplished on a

ship-to-shop basis or by the repair activity sending personnel aboard ship to perform the work.

In home-port areas such as Norfolk and Charleston, unscheduled work is placed with both the local naval shipyard and the private sector. The nature of the work and the workload of the cognizant shipyard shops are determining factors as to where the work is placed. In a home-port area such as San Diego, where there is no naval shipyard, emergency work is placed with private contractors.

As noted earlier, all private contractors who perform work on naval ships are holders of Master Contracts for Repair and Alteration of Vessels, commonly referred to as the MSRC. This contract contains forty-eight clauses to which the private contractor agrees when he signs the contract. One of these clauses, (3b), conveys the authority for the SUPSHIP to order a capable MSRC holder to perform emergent work on a naval vessel. Clause 3b is invoked whenever the contracting officer determines that a vessel, its cargo, or stores would be endangered by delay, or whenever military necessity requires immediate performance of the work. The MSRC will be discussed more extensively in a later section of this chapter.

Unscheduled repair work that is not of an emergency nature or a military necessity would be placed in the private sector by either formal advertising or negotiation. These procedures are discussed below.

F. CONTRACTUAL PROCEDURES FOR PLACING SHIPWORK IN PRIVATE SHIPYARDS

Naval ship industrial work is placed in a private shipyard[1] by the SUPSHIP for the Navy.[2] There are fifteen SUPSHIP offices

[1]Private shipyard, as used in the context of this discussion, means any private shipyard or repair facility holding a MSRC.

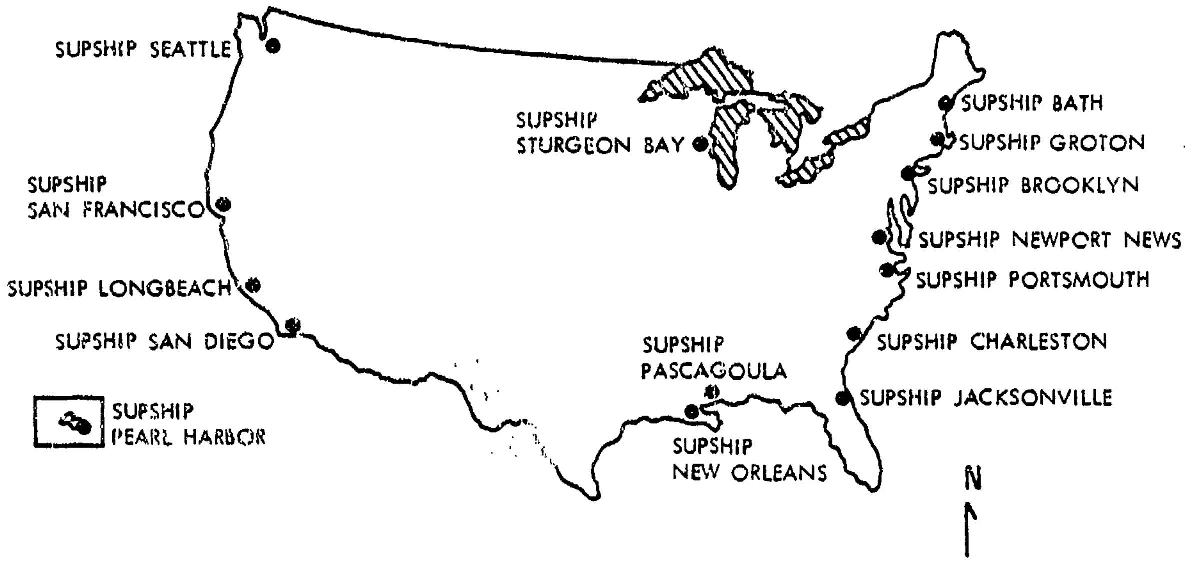
[2]Placing shipwork with private contractors is accomplished within the statutory regulations, policies, and procedures (continued on next page)

throughout the United States, as shown in Figure 32. Eleven of the offices have cognizance over Navy shipwork assigned to private shipyards in a defined geographical area, while four are responsible for Navy work placed in a single contractor's facility. The latter category includes the SUPSHIPs at Bath, Groton, Newport News, and Pascagoula. The standard organization of the SUPSHIP office is displayed in Figure 33. Appendix M describes the specific functions of the components of the organization and the overall mission and functions of the SUPSHIP office.

The typical SUPSHIP office has six departments. Three or four of these departments have personnel engaged in daily contact with private shipyard personnel during performance of work by that yard for the Navy. Changes in work specifications or requests for new work are usually processed within the SUPSHIP organization by all of these personnel. This situation, which requires the private contractor to deal with three, four, or more representatives of the Navy for changes or additional work, has led to allegations by private contractors that local Navy officials lack or fail to use discretionary authority. Some private shipyard managers have characterized the situation as one in which they could find several SUPSHIP personnel on the scene who could say no, but no one who would say yes.

In contrast with the Navy, both the Coast Guard and commercial ship operators vest the responsibility for local decision-making in a single person. The Navy has the mechanism to delegate limited contracting authority to persons other than the contracting officer. This authority is provided in the

(cont'd) set forth in the Armed Services Procurement Regulation (ASPR), Navy Procurement Directives (NPDs), and the Ship Repair Contracting Manual (Repair Manual). The ASPR is published by the Assistant Secretary of Defense (Installations and Logistics), the NPDs by the Navy Material Command, and the Repair Manual by NAVSEA (NAVSEA 0900-LP-079-5010, Ship Repair Contracting Manual, 1974 edition, Washington, D.C.).



Source: NAVSEA Industrial Activity Work and Resources Planning Division

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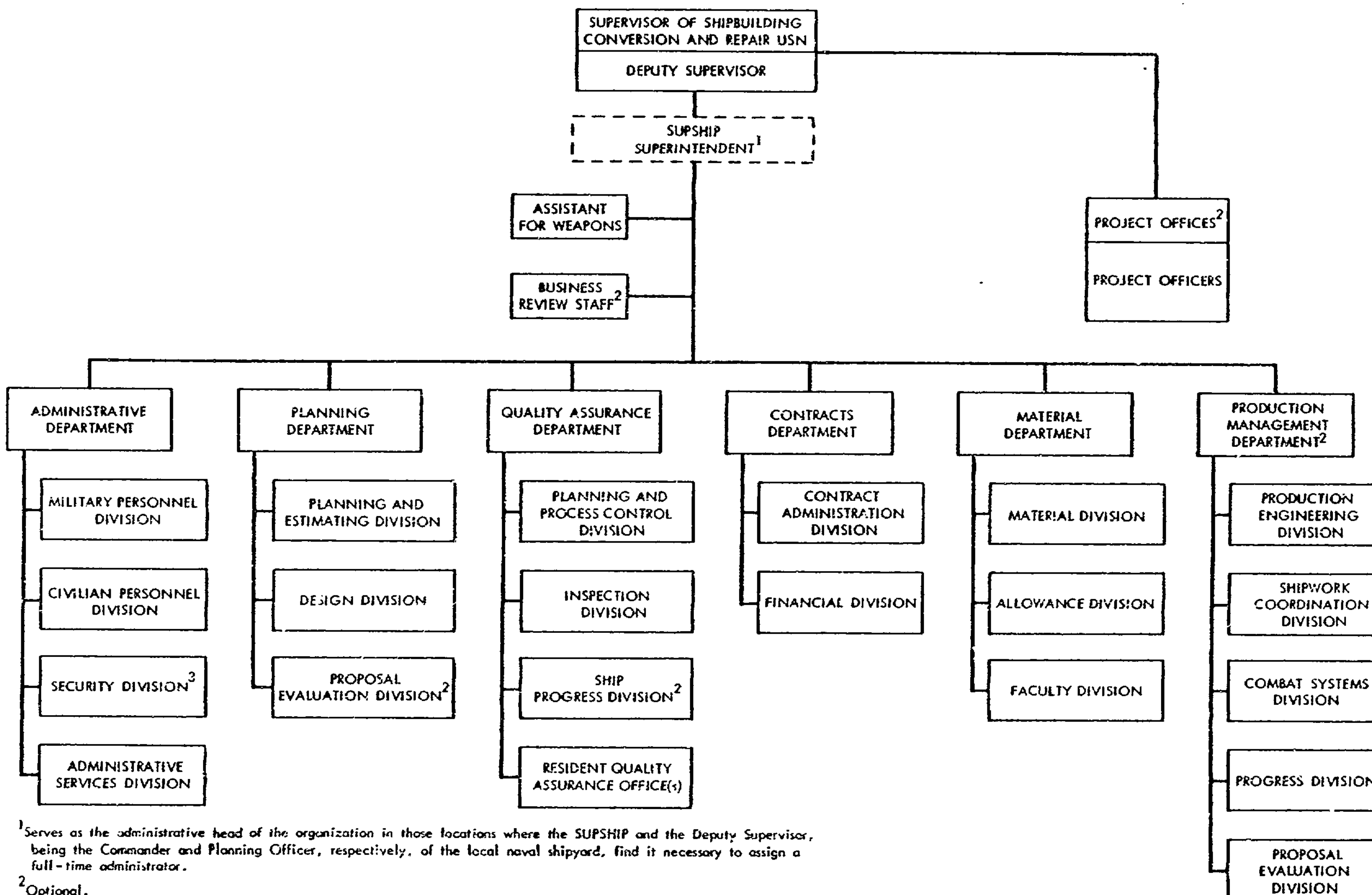
Figure 32. LOCATIONS OF SUPERVISORS OF SHIPBUILDING, CONVERSION, AND REPAIR

Ship Repair Contracting Manual, which is referred to as the Repair Manual.

NAVSEA has developed the Repair Manual to aid the SUPSHIP in placing and administering contracts and job orders for the repair, overhaul, and alteration of naval vessels at private shipyards. The manual is a ready reference to the statutory regulations, procedures, policies, and principles that condition and affect the procurement, administration, and performance of services under the MSRC. It is intended for use by all SUPSHIPs to ensure that approved procedures are followed consistent with public laws and government policies.

Article 5-6 of the Repair Manual permits appointing supervisory inspectors, surveyors, or individuals in charge of the performance of job orders at contractors' plants as contracting officers with the authority to execute the following:



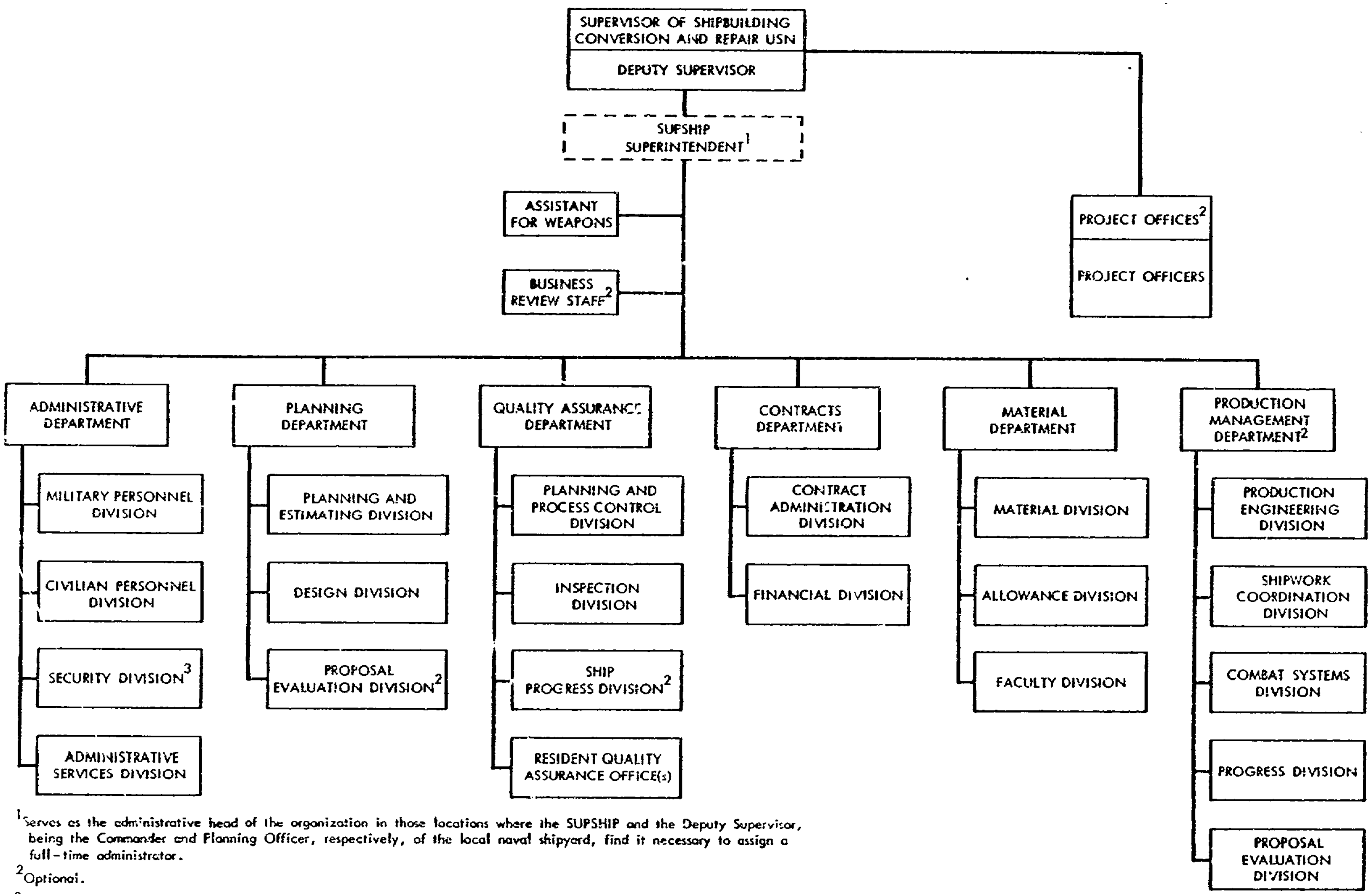
[1] Serves as the administrative head of the organization in those locations where the SUPSHIP and the Deputy Supervisor, being the Commander and Planning Officer, respectively, of the local naval shipyard, find it necessary to assign a full-time administrator.

[2] Optional.

[3] Where authorized.

Source: NAVSEA SUPSHIP Management Division.

Figure 33. ORGANIZATION OF THE OFFICE OF SUPSHIP



[1] Serves as the administrative head of the organization in those locations where the SUPSHIP and the Deputy Supervisor, being the Commander and Planning Officer, respectively, of the local naval shipyard, find it necessary to assign a full-time administrator.

[2] Optional.

[3] Where authorized.

Source: NAVSEA SUPSHIP Management Division.

Figure 33. ORGANIZATION OF THE OFFICE OF SUPSHIP

(1) change orders having an estimated gross value not exceeding $10,000 under the job order,

(2) supplemental agreements reflecting equitable adjustments resulting from change orders, provided the adjustment is priced on the basis of price analysis,

(3) supplemental agreements providing for additional work within the scope of the job order, provided the price adjustment does not exceed $10,000 gross and is based on price analysis,

(4) supplemental agreements for unresolved work not exceeding $10,000 gross, and

(5) supplemental agreements that establish maximum or minimum prices for additional work not to exceed $10,000.

There appears to be a need to streamline the Navy's method of contract administration on scene at the contractor's shipyard using authority provided by the Repair Manual. Chapter VII contains a specific recommendation on this subject.

Armed Services Procurement Regulation 16-503.1 prescribes the form of the MSRC and requires that this form be used by all military services, including the Military Sealift Command. Thus, a single private contractor may hold several MSRCs. This contract establishes in advance the terms upon which the private contractor will perform repairs, completions, alterations of and additions to vessels and parts thereof under the provisions of job orders issued by government contracting activities.

MSRCs are awarded to private shipyards following their written request for award and an affirmative determination by a field contracting officer.[1] Prior to this determination, a survey of the commercial shipyard is made to ascertain the firm's qualifications. A survey team comprising qualified

[1]A field contracting officer is the term applied to contracting officers in SUPSHIP offices. Contracting officers are selected and appointed in compliance with ASPR 1-405, Navy Procurement Directives, and the Repair Manual.

SUPSHIP personnel conducts an on-site survey to appraise the contractor's management, labor, and facilities. Criteria used for determining the qualifications are contained in ASPR 1-902 and 1-903, ASPR appendix K, and DD Form 1524, supplemented by criteria contained in Chapter 4 of the Repair Manual. The main areas evaluated are listed below:

Management, Engineering and Technical Personnel
Administrative Control Over Current Operations
Facilities
Financial Condition
Zoning Restrictions, if any
Prior Experience of the Shipyard
Facilities for Accommodating Personnel of the Ship
Facilities for Providing Standard Services to the Ship
Quality Assurance Capabilities
Health and Safety Practices, and Fire Protection
Guard Service
Equal Opportunity Employment Procedures.

A contractor who meets the criteria based on the evaluation of the survey team is awarded a MSRC. This contract is signed by a duly authorized official of the private contractor and the field contracting officer for the government.

Prior to actually awarding a contract for depot maintenance work, the Navy generally performs a pre-award survey of contractors who wish to bid on the work in spite of the fact that the contractors have MSRCs. In deciding whether to conduct a pre-award survey many factors are considered, for example, the nature of the proposed work, recent experience of the contractor on other Navy work, and financial status of the contractor.

These procedures do not ensure that the best qualified contractor receives a specific job. Marginally qualified contractors or contractors relying heavily upon sub-contractors will be awarded job orders if they are the lowest responsible

bidders. Current regulations require the field contracting officer to determine the responsibility of a contractor. In fact, the field contracting officer is placed in the position of having to prove that a contractor is not responsible if that contractor is to be disqualified. This situation has led to complaints from some private contractors who have been underbid by so-called marginal contractors because the field contracting officer could not develop a sufficient legal case of non-responsibility. This situation is the subject of recommendation in Chapter VII of this report.

In placing work under the MSRC, the field contracting officer uses the method of procurement he believes will be most advantageous to the government--price, quality, and other factors considered. The Repair Manual states that "such procurement shall be made on a competitive basis, whether by formal advertising or by negotiation,[1] to the maximum practicable extent, in accordance with the policies and procedures set forth in ASPR, NPD and this manual." This policy is further amplified in the Repair Manual: "procurement shall be made by formal advertising whenever such method is feasible and practicable, even though the conditions and circumstances would otherwise satisfy the requirements for negotiation."

The objective of this formal method of procurement is to obtain the most advantageous contract for the government and to permit all qualified contractors to bid fairly on Navy business. Competition is sought by soliciting competitive bids during procurement, by formal advertising, and by proposals during procurement by negotiation. Bids or proposals are solicited from the maximum number of qualified sources consistent with the nature of the requirements for the work to be performed.

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[1]Negotiation describes all contracting or purchasing that is not accomplished by formal advertising procedures set forth in Section II of ASPR and in NPDs. Section III of ASPR and NPD cover negotiation procedures.

As stated earlier, the field contracting officer decides whether a job order placed under the MSRC shall be awarded by means of formal advertising or by negotiation. To assist him in making the decision, the Repair Manual lists four prerequisites for formal advertising:

(1) A complete, adequate, and realistic specification or purchase description must be available;

(2) There must be two or more suppliers available, willing, and able to compete effectively for the repair work;

(3) The selection of the successful bidder can be made on the basis of price and quantifiable factors only; and

(4) There must be sufficient time to prepare a complete description of the work and to carry out the administrative procedures required in advertising.

The SUPSHIP planning officer normally advises the field contracting officer concerning the practicability of using formal advertising to award job orders to private contractors for the accomplishment of unscheduled repairs. There are circumstances when formal advertising may not be practical, and contracts are let based on negotiation.

The authority for the field contracting officer to negotiate is contained in 10 U.S.C. 2304(a) and ASPR Section III, Part 2. Title 10 of the U.S. Code contains seventeen exceptions to formal advertising that permit negotiation. Normally, only six of these exceptions are used by the SUPSHIP. Five require written justification for the use of negotiation in lieu of formal advertising. Negotiation for purchases of not more than $2,500 does not require this justification. The written justification takes the form of a Determination and Findings (D&F), which is signed by the field contracting officer or the Secretary of the Navy.

The six exceptions normally used by SUPSHIP are discussed briefly below and the authority cited.

(1) Public Exigency (10 U.S.C. 2304(a)(2) - ASPR 3-202).

This exception is used when there is insufficient time to prepare plans and specifications necessary for formal advertising. Voyage repairs and other emergency repairs normally fall within the scope of this exception. In these cases, the field contracting officer prepares and executes a D&F.

(2) Purchases Aggregating Not More Than $2,500 (10 U.S.C. 2304(a)(3) - ASPR 3-203).

This exception applies to minor procurements and particularly to repair of single items of equipment under a technical availability. It is intended to reduce administrative costs for small purchases. A D&F is not required.

(3) Supplies or Services for Which It Is Impractical to Secure Competition by Formal Advertising (10 U.S.C. 2304(a)(10) - ASPR 3-210).

The ASPR lists eighteen circumstances that apply to this exception; the Repair Manual, however, states that normally only four circumstances are appropriate to ship repair.

(a) Sole source of supply because of a single contractor or vendor, which may have been caused by imposed geographical restrictions.

(b) No responsive bid to formal advertising.[1]

(c) The contemplated procurement involves construction, maintenance, repairs, alterations or inspection, in connection with any one of which, the exact nature or amount of work to be done is not known.

(d) It is impossible to draft, for a solicitation for bids, adequate specifications or other adequately detailed description of the required supplies or services.

The field contracting officer prepares and executes the D&F. ASPR 3-102(c) requires that a noncompetitive procurement in excess of $10,000 be reviewed in advance at a higher level

[1]The invitations for bid and the requests for proposal are restricted to small business concerns.

than the field contracting officer. Such a review may be required under this exception.

(4) <u>Small Business Set-Asides (10 U.S.C. 2304(a)(1) - ASPR 3-201.2(b)(ii).</u>

This is an exception to place business with small business as defined in the Small Business Act. This procedure is termed a small business set-aside and is entered into by conventional negotiation or by a special method of procurement known as "Small Business Restricted Advertising."[1] The latter method is to be used whenever possible. Navy Procurement Directives require that a special justification in the form of a Memorandum for File be executed by the field contracting officer.

(5) <u>Classified Purchases (10 U.S.C. 2304 (a)(12) - ASPR 3-212).</u>

This exception may be used when work to be performed involves access to material classified confidential or higher and it is necessary to maintain security control over the solicitation. If only a portion of the job involves classified work, the field contracting officer determines if it is in the best interest of the government to advertise. Use of this exception requires the field contracting officer to prepare a D&F for execution by the Secretary of the Navy.

(6) <u>Negotiations After Advertising (10 U.S.C. 2304(a)(15) - ASPR 3-215).</u>

This exception may be used to negotiate after a D&F has been made that following formal advertising, the bids received were unreasonable or were not independently reached in open competition. After completion of the negotiation, a second D&F must determine that the negotiated price is lower than the lowest responsible bid price of a responsible bidder. Both D&Fs must be executed by the Secretary of the Navy.

[1]The invitations for bid and the requests for proposal are restricted to small business concerns.

The Navy has also expressed an intent to increase the use of negotiated procurement under another ASPR exception, ASPR 3-216 "Purchases in the Interest of National Defense or Industrial Mobilization," as one means of increasing the number of overhauls for complex combatant ships that can be accomplished in private shipyards. This exception provides negotiation authority that can be used to direct complex overhauls to the private shipyards that are selected by the Navy as best qualified to perform this important work. The increasing number of complex combatant ships, the growth in the size of overhaul work packages for these ships, and the projected small rate of increase in employment levels in naval shipyards indicate that a larger number of complex overhauls may have to be allocated to private shipyards in the future. The fact that there are currently only seven private shipyards capable of performing these overhauls will limit the extent to which the Navy will be able to accomplish this unless private shipyards are provided incentives to improve their capability.

One method of solving this problem is to combine the use of negotiated procurement with the use of multi-ship overhaul packages. Under this approach, the Navy would negotiate and contract with a single private shipyard for a series of overhauls. Thus, the private shipyard would be assured of a long-term workload comprised of a series of overhauls on the same type of ship and should benefit from being able to plan operations on a longer range basis. The prospect of this long-term workload should provide incentives for more private shipyards to invest in facilities and labor skills needed to permit them to bid on and accomplish this work. The Navy, in turn, should benefit from the existence of a larger number of qualified private shipyards in which overhaul of complex combatant ships can be performed.

Table 23 compares the supporting documentation required in the contract files for a job order awarded by the SUPSHIP under formal advertising and through negotiation. This table also provides some insight into the steps that must be taken by the SUPSHIP to award a job order to a private contractor. These steps will be outlined in the context of earlier discussions of the scheduled work package development and unscheduled industrial work.

Scheduled work is normally placed in the private sector by formal advertising. Figure 34 depicts the ship repair work flow to place a job order. The overhaul of combatant ships assigned to the private sector may result in negotiation, because of limitations in manpower and facilities in most private shipyards. During the work package development phase, described earlier, SUPSHIP evaluates the potential availability of drydocks and the current and predicted workload in the geographic area specified by the type commander. The type commander may be faced with excessively high bids if bidding is limited to companies in the home-port area. This evaluation may lead to a recommendation to expand the solicitation area if it appears that there will be inadequate competition.

For ship overhauls assigned to the private sector, the SUPSHIP considers split-bidding, i.e., dividing the overhaul into drydock and non-drydock ("topside") work. This practice permits small private shipyards to bid on only the topside portion, maximizes competition, and in many cases, achieves more favorable prices. In 1974, for example, one SUPSHIP, by split-bidding repair work on destroyers, received bids from smaller yards that were consistently at least $800,000 lower than those submitted by the larger shipyards. Although not of the same magnitude, split-bidding other types of ships provided similar results. The major disadvantage of split-bidding relates to time required for overhaul. The duration of the overhaul is increased by at least the length of the drydocking

Table 23. SUPPORTING PAPERS REQUIRED IN CONTRACT FILES FOR JOB ORDER AWARDS BY FORMAL ADVERTISING AND BY NEGOTIATION

Supporting Documents	Formal Advertising	Negotiation
Ship's force work requests	X	X
Type commander approval	X	X
Alteration authorization letters	X	X
Funds allocations	X	X
Work item specifications	X	X
Split bid determination	X	X
Small business set-aside recommendation with the field contracting officer's action	X	X
Geographic restriction, adequate competition determination, and request to type commander for enlargement of solicitation area	X	X
Determination and Findings		X
Sole-source determination*		X
Memorandum for File for negotiation of small business set-aside*		X
Foreseeable cost computation and supporting data*	X	X
Liquidated damages computation and supporting data*	X	X
Synopsis of procurement	X	X
Government estimate	X	X
Invitation for bids (IFBS)	X	
Request for proposals (RFPS)		X
Amendment to IFB/RFP*	X	X
Bids	X	
Proposals		X
Abstract of bids/proposals	X	X
Late bid/proposal documentation*	X	X

(continued)

*These documents are prepared on an as-required basis.

Table 23 (Cont'd)

Supporting Documents	Formal Advertising	Negotiation
Mistake in bid documentation*	X	
Confirmation of low bid	X	
Advisory Audit Report		X
Technical Advisory Report		X
Profit Computation		X
Pre-award survey	X	X
Business clearance	X	
Pre-negotiation business clearance		X
Post-negotiation business clearance with Memoranda of Pricing Considerations		X
Equal Employment Opportunity Clearance if the award is over $1,000,000*	X	X
Chief of Information clearance if the award is over $1,000,000*	X	X
Certificate of current cost or pricing data		X
Synopsis of award	X	X
Job order award	X	X
Memoranda or summary statements of undocumented actions such as conferences, telephone conversations, reviews, studies, determinations, and decisions	X	X
Notification to unsuccessful bidders	X	
Notification to unsuccessful offerers		X

*These documents are prepared on an as-required basis.

Source: "Ship Repair Contracting Manual," 1974 edition.

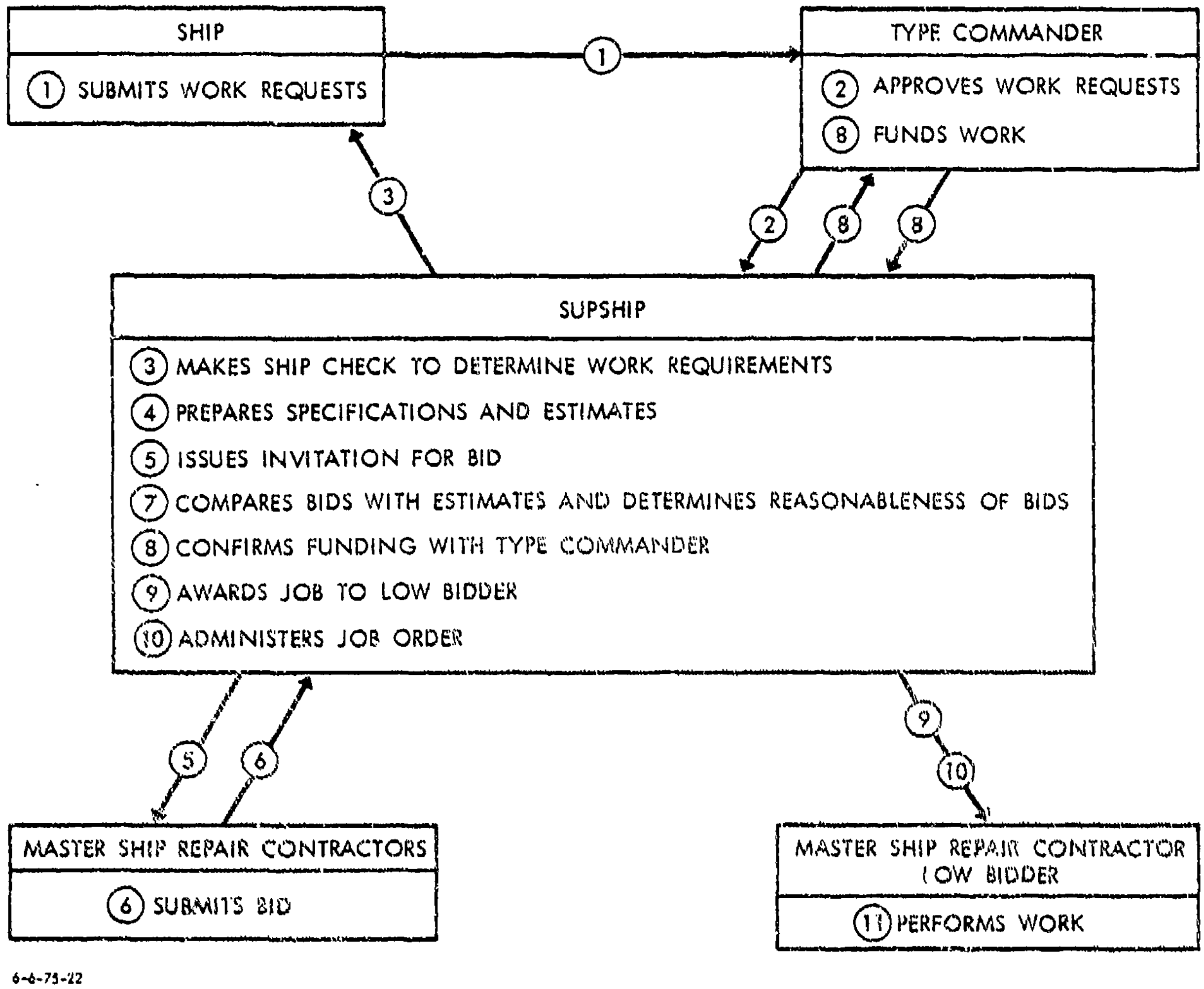

Figure 34. SHIP REPAIR WORK JOB ORDER FLOW

period, and if growth in the work package occurs during the first contracting period causing a schedule delay, the following contract may be adversely affected. The longer period required for the overhaul results in an opportunity cost because during this period the ship is not available to meet possible operational requirements in the fleet. The decision for split-bidding must be made on an individual basis after a trade-off analysis has been conducted of time and dollars required for overhaul versus value of operational time with the fleet.

The Repair Manual requires the field contracting officer to use split-bidding whenever feasible. When it is not used, contract files must document each case to indicate the justification for the decision.

Split-bidding is accomplished by dividing the ship work package into three lots. Lot 1 is topside work only, lot 2 is drydock work only, and lot 3 is the total job. A contractor may bid on only lot 1 or on lot 2, but if he bids for the total job (lot 3), he must also submit bids for lots 1 and 2 separately. An exception is made for a contractor who is unable to bid on lot 2 because of a prior drydocking commitment for the dates specified. Under these circumstances, a contractor would submit bids for only lots 1 and 2.

The field contracting officer may reject bids for lots 2 and 3, if unreasonable, and award only lot 1 to the lowest bidder. When no bids are received for lot 2 and negotiation is impractical for other reasons, the field contracting officer may explore the possibilities of placing the drydock work in a naval shipyard. This procedure is being used in port areas, such as Norfolk, where the private sector has limited drydock capability and the existing capacity is saturated.

Unscheduled availabilities previously described as restricted or technical availabilities and emergency voyage repairs require the SUPSHIP to act expeditiously. The SUPSHIP planning officer and the field contracting officer examine the circumstances to determine the time available to place a job order and the most suitable method of procurement. An emergency repair may require the field contracting officer to request representatives from qualified firms to accompany him and SUPSHIP job planners to inspect the requested work aboard ship as soon as possible. Based on the examination, the planners may write a specification on the spot or the field contracting officer may solicit quotations, without specifications, on the basis of the inspection and the repairs needed. The interested

contractors may be requested to submit their quotations immediately.

Oral solicitation for work exceeding $2,500 should rarely be required, and it does not relieve the field contracting officer of complying with the applicable portions of the ASPR, NPDs, and the MSRC. The same contract-file supporting papers are required. As discussed earlier, in cases of emergency or military necessity, the field contracting officer may order work accomplished under clause 3(b) of the MSRC.

Under the existing procurement directives and the MSRC, the SUPSHIP has the tools to place work by various means from formal advertising, through different types of negotiations, to a unilateral order. Response time can be varied to meet the needs of the circumstances involved in accomplishing the job order.

G. SUMMARY OF PROCEDURES TO PLACE SHIPWORK

The Navy ship depot maintenance program, a $1.4 billion program in fiscal year 1974, provides funding through the Operations and Maintenance, Navy appropriation, for scheduled and unscheduled maintenance, including installation of ship alterations. Representatives of the private shipbuilding and repair industry have advocated placing 50 percent of the Navy's ship repair work in private shipyards. Over the past ten years, the Navy has allocated an average of 27 percent of this work to the private sector. Adding conversions, funded by the Shipbuilding and Conversion, Navy appropriation, to ship repair work increases the average percentage of Navy shipwork performed by private shipyards over the past ten years to more than 30 percent.

An overhaul schedule is developed annually for each fleet, Atlantic and Pacific, through the interaction of the CNO Material Readiness Division (OP-43), Systems Analysis Division (OP-96), Fiscal Management Division (OP-92), NAVSEA, and the

fleet and type commanders' staffs. This is about a six-month process (January through June) and coincides with the formulation of the Navy's POM. The existing overhaul schedule forms the basis for development of the new schedule.

In the present fiscally constrained environment, the depot maintenance requirements identified by the Navy continually exceed the funds allocated for that purpose. NAVSEA converts dollars for ship overhauls into production shop mandays and applies an appropriate manning curve for each type of ship to produce a Productive Workload Forecast for each naval shipyard. This document is updated monthly to continuously project the workload twelve months in advance. The distributing and balancing of the workload by NAVSEA involves consideration for the following factors:

(1) Carryover of workload from the previous fiscal year.
(2) The Navy's home-port policy.
(3) Facilities at each naval shipyard.
(4) Productive work force available in each naval shipyard, considering imposed personnel ceilings.
(5) Trades balance within individual shipyards.
(6) Special capabilities of individual shipyards and past performance.
(7) The naval/private workload distribution policy.
(8) Tentative availability dates.
(9) Characteristic manning distribution for various types/classes of ships.
(10) Need for uniform workload distribution.
(11) Inputs from the ship ds concerning specific workload and manning problems.

The work package to be accomplished during an overhaul is developed through an advance planning process that begins about 360 days prior to the overhaul start date. Advance planning is centrally managed for the NAVSEA ship's logistic manager and type commander by one of five PERA offices. Each PERA is responsible for certain types of ships.

The PERA tasks the overhauling naval shipyard, planning yard or, if the ship is to be overhauled in the private sector, the SUPSHIP to perform certain functions in advance planning. In the advance planning process, the alterations most likely to be accomplished and the repairs needed are evaluated. Deferred maintenance from ship's records and work identified during a POT&I are integrated with validated alterations to form the SARP.

A work definition conference involving the type commander, PERA, overhauling naval shipyard (SUPSHIP, if assigned to the private sector), the ship, and an intermediate maintenance activity (if available) is held to approve and assign the work to be accomplished. After this conference, a final SARP is published, which becomes the official authorizing document between the type commander and the naval shipyard or SUPSHIP. The naval shipyard uses this document to write job orders, and the SUPSHIP uses it to write specification for formal advertising or negotiation with private shipyards.

To be eligible to bid or make a proposal on Navy work, a private shipyard must hold a MSRC. This contract is awarded by a Navy field contracting officer after a survey of the private shipyard is made to determine the firm's qualifications. This form of contract is authorized by the ASPR to establish in advance the terms upon which a private contractor will perform shipwork. Under this contract, the SUPSHIP may order emergency work to be performed by a private contractor holding the MSRC.

The SUPSHIP organization of 15 offices administers the MSRCs and other ship procurement contracts. Procurement of shipwork is accomplished as prescribed by the ASPR, NPDs, and the Ship Repair Contracting Manual. These regulations and directives prescribe formal advertising as the primary method of procurement; however, where circumstances make formal advertising impractical, negotiation may be used. Negotiation

is authorized under the 17 exceptions contained in the ASPR and normally requires written justification in the form of a D&F. In either method, procurement must be made on a competitive basis to the maximum practicable extent.

The SUPSHIP, who is in daily contact with representatives in the private sector, is in a good position to advise the type commander on conditions in the geographic area of competition and whether to split bid. In adhering to the Navy's home-port policy, the type commander attempts to have as much shipwork accomplished in a ship's home port, or as close thereto, as possible. High prices resulting from heavy demands on local private shipyards may force extending the area of bidding to outside the home-port area and in some cases to coast-wide bidding to obtain a reasonable price.

Split-bidding (separating the underwater body work, which requires drydocking, from the rest of the work--topside work) generally extends the time required to accomplish the work. Offsetting that disadvantage are the lower bids usually received for the work, because many small ship repair contractors who do not possess drydocks can now bid on the topside work package. The type commander evaluates the advantages and disadvantages (both tangible and intangible) of the various alternatives and decides on which course of action to follow.

Establishing fleet overhaul schedules, identifying the work to be accomplished, and contracting for the work are components of an extended and involved process. Within the volumes of regulations and implementing directives, mechanisms exist for orderly planning and accomplishing of overhauls, as well as for providing a rapid response capability for accomplishing unscheduled emergent work.

Chapter IV

PERFORMANCE INDICATORS FOR NAVAL SHIPYARDS

Efficiency and effectiveness are two basic considerations in measuring the performance of an industrial activity in accomplishing its assigned work.[1]

- *Efficiency measurement* compares performance with some standard to determine how well an activity is utilizing available input resources to produce a given output.
- *Effectiveness measurement* compares performance with end objectives to determine how well an activity is accomplishing its goals.

Generally accepted overall performance measures for industrial repair and overhaul activities, such as naval shipyards, do not currently exist because of the difficulty of obtaining directly quantifiable measures of output and input. Hence, substitute performance indicators, parameters that provide the basis for trend analysis without measuring performance in absolute terms, must be used. This trend analysis, in turn, can provide the opportunity to improve overall performance despite the lack of absolute measures.

This chapter defines and discusses several performance indicators for naval shipyards in terms of their current general mission--ship depot maintenance.[2] The purpose of the

[1]U.S. Army, Management Engineering Training Agency, *Improving Work Measurement Systems in the Federal Government*, June 1973.

[2]The discussion in this chapter assumes some familiarity with the operation of naval shipyards under the Navy Industrial Fund. Those readers who lack this background may wish to review Appendix N of this study.

discussion is to demonstrate the utility of the indicators as management tools.[1] The indicators selected are derived from the large amount of detailed cost and labor manhour data routinely available in NAVSEA on naval shipyard performance. These indicators may be grouped into the following two general categories:

- Labor ratios
- Cost-per-direct manday ratios.

Included in the discussion of each indicator are comments about derivation, interpretation, and limitations.

This chapter also discusses four areas in which positive management action would result in improving the overall performance of naval shipyards despite the fact that the level of performance and resulting improvements cannot be measured in absolute terms.

A. THE CONCEPT OF PRODUCTIVITY

Before discussing the overall performance of naval shipyards, we will consider the concept and use of the term *productivity* to help place the remainder of the chapter in perspective. Productivity is an important concept in measuring the performance of industrial activities. It is, however, only one of several approaches to measuring efficiency.[2] The focus

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[1] Similar indicators are not presented for private shipyards, although the same indicators could be used to evaluate their performance. Considerably more research of the private sector experience would be required to develop these indicators, however, because detailed cost and manhour data are not routinely available within NAVSEA on private shipyard performance. Most ship depot maintenance accomplished in private shipyards is done under fixed-price orders for which contractors are not required to disclose actual cost and manhour data.

[2] Another approach to measuring the efficiency of an industrial activity is unit-cost measurement—the activity that produces a given output at the lowest cost is more efficient than others. Measurement of work performed against work standards is an example of another.

here is on measuring overall performance rather than examining solely the question of productivity.

Productivity in industrial activities is a broad concept that expresses the relationship between the quantity of goods and services produced--output--and the quantity of labor, capital, land, energy, and other resources that produced it--inputs.[1] Productivity indexes, therefore, are output-input ratios that provide a convenient measure of variations in productivity among industrial activities over time. Because the basic concept is broad, productivity means different things to different people, and efforts to evaluate productivity have taken many forms. While many of the measures that purport to be productivity measures[2] have proved useful in evaluating the performance of naval shipyards, no single measure has achieved general acceptance, as noted above, because of the difficulty encountered in measuring outputs and inputs for overhaul and repair activities.

1. Output

The output side of the productivity index refers to the finished product of the industrial activity. The final output level is easily determined for activities that produce a single homogeneous product that can be measured by simply counting. The output of a repair and overhaul activity, such as a shipyard, is considerably more difficult to measure, since few tasks are identical in every respect. Individual tasks can be measured,

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[1]U.S. Department of Labor, Bureau of Labor Statistics, *Productivity and the Economy*, Bulletin 1779, rev., Washington, D.C., 1973.

[2]The term "productive ratio" has tended to become a part of the vocabulary in discussions about direct-to-total labor relationships in naval shipyards. This is especially true since the issuance of the FY 74 NIF Program/Budget Decision (PBD 102, 21 November 1973), which discussed labor ratios but did not use the term "productive ratio." (The IDA study team was unable to identify the initial use of the term.) Since these ratios address only inputs, it is inappropriate to imply that they are productivity measures. More is presented on this subject in Section B.2.

but it is difficult to aggregate these data to develop meaningful overall measures for an entire job and across several jobs.[1] As a result, straightforward, overall output measures that will facilitate comparisons among industrial activities do not exist for ship overhaul and repair.[2] Consequently, substitute indicators that attempt to identify changes in output by monitoring shifts in other parameters must be used. For example, various cost-per-labor manhour relationships (actually input indicators) may be used as surrogate output measures. Cost and labor manhours can be determined easily by existing measurement methods in naval shipyards.

2. Input

The input side of the productivity index may be interpreted in two ways. In a general sense, this side is a composite of all the tangible and intangible inputs required to produce a given output. The practical problem of identifying and measuring all inputs has not been solved, however, and no total factor measure has yet won general acceptance. Nevertheless, the importance of this approach must be considered since it

[1] Indicative of the difficulty of developing output measures for overhaul and repair activities is the work of a joint federal task group of the Joint Financial Management Improvement Program. The overall program was established by Congress in 1950. Since 1970, the joint task group has addressed the problem of improving productivity in the federal government with emphasis on output measures. OASD (I&L) is the OSD Principal on this group and the Navy also participates. In 1974, the task group reported quantified outputs covering 61 percent of the total FY-73 federal civilian employment. Of over 1.7 million manyears for which measures were reported, less than 100,000 were applicable to overhaul and repair. Of these, only 600 were applicable to naval shipyards. It is significant, however, that these 600 manyears represent the first output measure for naval shipyards. (Joint Financial Management Improvement Program, *Report on Federal Productivity*, 2 vols., June 1974, I:111.)

[2] For example, the number of ships completed is of little value because of differences in the number and complexity of repair items to be completed on each ship.

focuses attention on many input factors often overlooked in evaluating productivity.

An alternative approach involves consideration of a single, easily measured input resource. This approach makes the problem of measuring input more manageable since, for example, the amount of direct labor required to provide a given output, such as a completed ship overhaul, is normally available in considerable detail. The ease of measuring labor input, along with the importance of labor in many industrial activities, helps explain the widespread use of labor-productivity measures.[1]

B. PERFORMANCE INDICATORS

This section presents several overall indicators that can be used to monitor the efficiency of naval shipyards.[2] The indicators selected are not efficiency measures, but they provide the basis for identifying and evaluating trends that will direct management attention to areas requiring increased emphasis. This is an important first step in attempting to improve overall efficiency of the shipyard.[3]

The indicators selected are substitutes for generally accepted overall output and input measures that, as previously stated, do not exist for naval shipyards. These indicators[4] may be grouped into two general categories:

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[1]Labor-productivity ratios, normally of the form output per manhour, must be distinguished from labor ratios, such as direct labor expended per manhour assigned. The latter measure addresses input resources only and is not a productivity measure.

[2]The question of evaluating effectiveness is discussed in Section D.

[3]It is emphasized that shifts and trends in these indicators are not in themselves indicative of increased or decreased efficiency. Each indicator should be monitored and evaluated in the context of the overall operation based on the judgment and experience of managers at all echelons.

[4]These are the primary indicators. Secondary indicators are discussed at the end of this section.

- *Manday-labor ratios*, which facilitate monitoring the use of labor in the shipyards. The primary parameter of interest is the number of direct labor mandays expended (DMDE) to accomplish assigned workloads. Data relating total DMDE to total labor available are presented. Also provided are the relationships of total DMDE to shipwork and to the production centers where the work force is assigned.
- *Cost-per-direct-manday-expended ratios*, which facilitate monitoring cost trends in naval shipyards. The cost data used reflect the total cost incurred by naval shipyards in accomplishing assigned workloads. Data relating direct, overhead, labor, material, and "other" costs to total cost are also provided.

The period from FY-70 through FY-74 was chosen as an appropriate time span over which to analyze the selected indicators. This interval provided a sufficiently long span to illustrate the utility of the indicators and to identify recent trends without requiring a very large volume of computations. Annual ratios were selected for the same reason. While it is recognized that indicators computed on a more frequent basis are useful for study of specific problems, annual indicators are sufficient for the gross-level trend analysis discussed in this chapter. The idea underlying this assumption is that in some studies detailed analysis is a logical second step once annual data have focused attention on specific areas of interest.[1]

1. Basic Data Sources and Adjustments

The primary source of cost and labor manday data was the *Financial and Operating (F&O) Statements* published by the comptroller at each naval shipyard.[2] These documents are products

[1]The naval shipyard computerized management information system not only provides the data for computing these indicators on a daily basis, if desired, but also at a lower level of detail (e.g., by cost center or even job order). Similar indicators are provided, for example, in the monthly and quarterly *F&O Statements*.

[2]NAVSEA requires submission of detailed quarterly and abbreviated monthly statements. See Section E of Appendix N for more detailed discussion.

of the standard cost accounting system used in naval shipyards and provide, among other things, operating cost and labor summaries for all work accomplished.[1] The statements, as of June 30 for each year from 1970 through 1974, were used to provide actual cost and manhour data by fiscal year. Personnel data, including total employment levels, were extracted principally from *Statistics of Naval Shipyards (SONS)* unless otherwise indicated on the tables accompanying this discussion.[2] Table 24 summarizes the basic data used, the sources, and the adjustments made when required.

2. Labor Performance Indicators

Because ship overhaul and repair is a labor-intensive industrial activity, the application of labor to accomplish assigned workloads is of vital importance to shipyard management. Labor ratios provide a means of monitoring the use of this important input resource. Significant shifts in these indicators can focus management attention on areas that provide the opportunity for improving overall performance. Labor ratios also can be of value in a gross assessment of alternative workload and work force courses of action for naval shipyards.

Labor ratios take many forms. In most cases, the primary parameter of interest is the number of direct labor mandays expended to accomplish assigned workloads. This indicator, although not an absolute measure of the amount of work accomplished, is probably indicative of the level of activity within a shipyard. Thus, it is an especially useful indicator to relate to other parameters for general trend analysis. This

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[1] The Navy has succeeded over the years in eliminating most differences in interpretation that have occurred. Currently, the minor differences that remain are at a low level of detail and do not distort most analyses.

[2] Published quarterly by the Industrial Activity Performance Evaluation Division, NAVSEA (072).

Table 24. OVERVIEW OF BASIC DATA SOURCES AND ADJUSTMENTS

Data Item	Source	Remarks
1. Total Mandays Available	*SOMS*, Table 1, "Force Distribution in US Naval Shipyards by Functional Category." (Number of Employees by Shipyard)	Provides total number of employees by quarter. The average number of employees per year per yard was computed and converted to mandays on the basis of 2000-manhours for one productive manyear. This is the depot level planning factor specified by DoDI 4151-15.
2. Total Direct Mandays Expended Total Direct Mandays Expended for Shipwork	*F&O Statements*, "Cost and Budget Summary of Work in Process by Work Category"	Provides manday data by regular and overtime direct mandays worked.
3. Total Direct Mandays Expended by all Production Centers	*F&O Statements*, "Summary of General Expense Distribution"	Provides total direct labor hours by type of cost center.
4. Total Direct Mandays Expended by Production Department Productive Shops	*F&O Statements*, "Detailed Overhead Expense Summaries"	Provides total direct labor hours by cost center.
5. Costs Incurred to Accomplish Assigned Work	*F&O Statements*, "Statement of Revenue and Costs"	Provides total costs and detail by direct and overhead categories and by labor, material and "other" cost elements. All costs were in current year dollars and were converted to constant FY-74 dollars to facilitate comparative analyses. Material costs were adjusted using the Bureau of Labor Statistics composite indices for industrial commodities. Labor costs were adjusted using indices derived from the average cost of labor at each sh pyard rather than a single index. Thus, labor costs are adjusted to reflect differences in each yard over time. Since detail was not available for the "other" cost category, these costs were adjusted using labor indices on the assumption that labor probably represents a significant part of these miscellaneous costs. Since total "other" costs is approximately 10 percent of total cost for each year, this assumption should not distort to a significant extent the performance indicators discussed.

section defines and discusses four labor ratios involving the number of direct labor mandays expended:

(1) Number of direct mandays expended to accomplish assigned workloads related to total mandays available.

(2) Number of direct mandays expended to accomplish shipwork related to the total number of direct mandays expended.

(3) Number of direct mandays expended by all production centers related to the total number of direct mandays expended.

(4) Number of direct mandays expended by the Production Department Productive Shops related to the total number of direct mandays expended.

Many other relationships could be computed, but these ratios are sufficient to illustrate how indicators can be used to monitor trends in the application of labor. Once significant trends are identified, analysis at a lower level, involving the appropriate measures and data, would logically follow to ascertain the actions management should take to influence future trends.

To facilitate comparative analysis, the four labor ratios selected are summarized in Table 25. Each ratio is discussed separately below. The actual data used to compute the ratios are presented, in tabular and graphical form, in a fold-out at the end of the discussion (see Figures 35 and 36).

Although labor ratios are useful to monitor trends in the utilization of labor, they have certain limitations. First, as pointed out earlier, labor ratios address only an input resource and, hence, are not productivity ratios. Second, these ratios ignore the productivity of direct labor, as well as the very important contribution of overhead labor and many other factors that cause output to vary as a function of direct labor input. Hence, labor ratios are not measures of labor efficiency and therefore should not be used to rank shipyards.

Table 25. SELECTED RATIOS FOR NAVAL SHIPYARD MANDAY LEVELS

Shipyard	Ratio				
	FY70	FY71	FY72	FY73	FY74[1]
DIRECT MANDAYS EXPENDED TO TOTAL MANDAYS AVAILABLE					
Boston	.54	.52	.55	.53	*
Charleston	.56	.56	.49	.49	.52
Hunters Point	.63	.58	.56	.55	*
Long Beach	.66	.65	.64	.60	.60
Mare Island	.54	.55	.53	.51	.54
Norfolk	.58	.58	.57	.53	.53
Pearl Harbor	.62	.63	.59	.55	.57
Philadelphia	.61	.59	.51	.52	.56
Portsmouth	.54	.50	.51	.47	.49
Puget Sound	.62	.58	.57	.51	.57
SHIPWORK DIRECT MANDAYS TO TOTAL DIRECT MANDAYS					
Boston	.88	.79	.79	.79	*
Charleston	.82	.86	.81	.82	.87
Hunters Point	.89	.90	.85	.86	*
Long Beach	.90	.90	.89	.91	.90
Mare Island	.78	.86	.84	.82	.86
Norfolk	.87	.91	.90	.90	.90
Pearl Harbor	.90	.91	.90	.88	.92
Philadelphia	.92	.89	.80	.81	.84
Portsmouth	.82	.80	.75	.76	.79
Puget Sound	.93	.91	.92	.87	.91
PRODUCTION CENTERS DIRECT MANDAYS TO TOTAL DIRECT MANDAYS					
Boston	.93	.89	.86	.89	*
Charleston	.92	.94	.94	.93	.92
Hunters Point	.96	.97	.96	.96	*
Long Beach	.96	.95	.96	.96	.97
Mare Island	.94	.93	.95	.94	.94
Norfolk	.94	.95	.94	.94	.94
Pearl Harbor	.96	.96	.95	.93	.94
Philadelphia	.94	.92	.90	.89	.90
Portsmouth	.91	.91	.86	.85	.85
Puget Sound	.94	.93	.93	.93	.94
PRODUCTION DEPARTMENT PRODUCTIVE SHOPS DIRECT MANDAYS TO TOTAL DIRECT MANDAYS[2]					
Boston			.73	.75	*
Charleston			.75	.73	.73
Hunters Point			.85	.86	*
Long Beach			.[illegible]5	.86	.85
Mare Island			.69	.69	.71
Norfolk			.81	.82	.83
Pearl Harbor			.81	.78	.79
Philadelphia			.76	.76	.78
Portsmouth			.63	.64	.64
Puget Sound			.73	.72	.74

[1]The asterisk in column FY74 indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years. Hence, these ratios were not computed.

[2]FY70 and FY71 totals for this category not separately reported.

Source: Derived from data in Figures 34 and 35.

a. Relationship of Direct to Total Mandays Available

Total employment in naval shipyards declined from approximately 82,000 at the end of FY-70 to about 60,000 at the end of FY-74, a net reduction of 27 percent. Employment levels in individual yards generally followed this same trend, except in FY-74 when the Boston and Hunter's Point Naval Shipyards were closed. As a result of these closings, four of the eight remaining yards experienced small increases in total employment as manning levels were adjusted. These increases were not sufficient, however, to offset the total reduction of naval shipyard employees due to the closing of two yards.[1] Over this same period, the total number of direct mandays expended by all Navy yards to accomplish assigned workloads also declined, from over 12 million in FY-70 to approximately 8 million in FY-74 for a net reduction of over 33 percent. Since the decrease in the number of direct mandays expended over this time span was greater than the decrease in the total number of mandays available, the ratio of direct to total labor also declined.

The first indicator summarized in Table 25 was selected to provide a gross indication of the relationship between the number of direct labor mandays expended and the total mandays available in each naval shipyard. In general, these direct-to-total ratios exhibit the same overall trend as described above. Practically all of the ratios lie in the range of 50 to 60 percent, and there is a gradual decline in all yards from FY-70 through FY-73. In FY-74, the relative adjustments in employment and direct manday levels that accompanied the closing of the two naval shipyards caused the ratios to either level off or increase slightly for the yards that remained open.

[1]As a result of the decline in total employment, five of the eight shipyards were manned from 3 to 20 percent below "low efficient capacity" as defined by the Navy in the 1974 House Seapower Subcommittee hearings, *Current Status of Shipyards, 1974*, 93rd Cong., 2nd sess., July-October 1974, Part I, p. 116.

Manday patterns at Puget Sound, the shipyard in which the largest ratio increase occurred, were examined in more detail to illustrate how analysis of changes in trends might help improve the overall efficiency of naval shipyards. As shown by the data in Figure 35, both total mandays available and the number of direct labor mandays expended at the Puget Sound Naval Shipyard increased in FY-74 over the FY-73 value. However, as shown by the change in their ratio (see Table 25), the number of direct labor mandays expended increased by a larger percentage than the total mandays available. One possible explanation for this relationship is that in expanding the total work force, emphasis was placed on hiring employees in those areas normally associated with performing work in direct support of customers. A further check of employment levels confirmed that of the increase of over 2,000 in total employment at Puget Sound during FY-74, over 70 percent occurred in the four Production Department shop groups. Hence, this limited example illustrates how one management decision influenced the labor trend in one yard.

Considerable caution must be exercised in interpreting this direct-to-total ratio. The major concern is the tendency to use such ratios to rank shipyards on an absolute basis. Each ratio represents a particular management solution to the problem of how best to apply the total available labor resource to accomplish all assigned workloads. There probably is not one "best balance between direct and total labor" (which implies a balance between direct and overhead costs) for all shipyards. There are many efficient combinations that could, theoretically, result in the same output.

Unfortunately, there is often a preconceived notion that it is always better to have more people working in direct jobs and fewer working in support positions.[1] Actually, different

[1]This is the basis for a management concept that speaks of decreasing the number of overhead (support) workers as an end in itself.

ratios could well lead to the same output. For example, one shipyard might elect to put more direct workers on a particular work package to reduce the time the ship is in the shipyard. This decision would tend to increase the direct-to-total-labor ratio for that shipyard. A second shipyard might elect to improve job planning and other support activities so the direct worker wastes less time when on the job and, hence, the time the ship is in the yard is reduced. This latter approach would tend to decrease the direct-to-total-labor ratio for that shipyard. In either case, the total time the ship is in the yard and the number of work items completed could be the same. Merely comparing labor ratios would be misleading in such a situation.[1]

Another caution that must be exercised in interpreting direct-to-total ratios is to determine explicitly the basis on which the ratio is computed, since many variations are possible. For example, the numerator is generally the amount of direct labor expended to accomplish work for customers. It is possible, however, to define direct labor based on personnel job descriptions rather than work performed. Obviously, use of these very different numerators would lead to widely different relationships. Variations, however, most often occur in the form of the denominator. The denominator may take various forms depending on the emphasis desired. In one instance, the denominator may be the sum of the direct and overhead labor hours actually worked. In another instance, the denominator may include absences so the total is more representative of total available labor.

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[1]Recent experience at Puget Sound and Portsmouth can be cited as evidence of contrasting management styles. The above discussion about emphasis on hiring direct workers at Puget Sound in FY-74 illustrates one approach. Experience at Portsmouth demonstrates another approach. In this shipyard a dramatic improvement in performance was achieved by placing additional resources in support activities to assure high quality and timely support to direct workers.

The major effect of using alternative ways of computing labor ratios is to change the levels of the ratios. As long as a consistent approach is used, however, all ratios provide the basis for trend analysis. To illustrate this point, labor ratios published by the Navy and the direct-to-total ratios in Table 25 can be compared.

The Navy routinely reports a labor-utilization ratio in the quarterly *SONS*.[1] Despite some variations in definition over the years, the ratio essentially expresses the relationship of the total number of regular time direct labor hours charged to job orders to the total labor assigned to the basic shipyard.[2] Table 26 summarizes these ratios for FY-70 through FY-74. Comparing these ratios with the direct-to-total ratios in Table 25 demonstrates the difficulty encountered in drawing meaningful conclusions from ratios computed on a different basis. The key factor in using the ratios is to understand the basis for computation of each and to select the one that focuses attention on the parameters of interest.

Note that the ratios in Table 25 are consistently higher than those published in *SONS*. The primary reason for this is that the numerators of the fractions used to derive the ratios reflect different measures of direct labor worked. The ratios

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[1]The Navy also includes this labor ratio in the material that supports the annual budget submission to OSD(C). As near as can be determined, OSD(C) has levied no written requirement to submit a specific ratio although various data on direct and total labor are required.

The term "productive ratio" is sometimes erroneously applied to the labor-utilization ratio. As pointed out earlier, labor ratios address only input resources and, hence, are neither measures nor indicators of productivity.

[2]Computed in this way, the ratio addresses over 98 percent of the shipyard work force. The remainder is assigned to tasks not included in the basic mission of the shipyard, such as the PERA Groups. This ratio also includes absences in the denominator. The Navy also publishes a "productive ratio" in some shipyard *F&O Statements*, which is similar to the labor-utilization ratio in the *SONS*, except that absences are not considered. Starting in FY-76, the Navy will adopt a new, standardized definition that will exclude absences from the denominator.

Table 26. LABOR UTILIZATION RATIOS FOR NAVAL SHIPYARDS BASED ON DATA IN THE "STATISTICS OF NAVAL SHIPYARDS"

(FY-70 through FY-74)

Shipyard/Fiscal Year	1970	1971	1972	1973	1974[2]
Boston	53.0	49.9	51.7	50.8	*
Charleston	50.1	47.3	44.6	49.7	48.2
Hunters Point	55.0	52.2	50.6	51.2	*
Long Beach	57.1	56.5	57.1	55.7	54.7
Mare Island	52.3	49.6	49.2	49.9	49.0
Norfolk	51.2	49.6	50.2	50.0	48.8
Pearl Harbor	54.4	52.3	52.2	52.5	53.9
Philadelphia	54.3	51.6	50.1	51.2	54.0
Portsmouth	50.5	46.9	47.2	46.3	47.7
Puget Sound	54.7	51.7	51.4	49.6	53.5
All Yards	53.2	50.7	50.4	50.5	51.2

[1]Ratio of direct labor charged to job orders to total available including absences.

[2]Asterisk indicates data not reported for FY-74 due to yard closures.

Source: Derived from Table 1 of NAVSEA's *Statistics of Naval Shipyards*, June FY-70 through FY-74; values shown are the average of the quarterly values displayed.

in Table 25 include all direct labor worked, regular and overtime. The Navy ratios exclude overtime.[1] Differences in the denominators may account for some of the difference in the ratios but, since both are estimates of total labor available, the impact is probably small. Note also that in some instances the ratios exhibit different trends. This fact, too, is probably due to shifts in overtime that occur in the ratios in

[1]Based on Chart I of the *SONS*, a reasonable estimate of the amount of overtime work in naval shipyards would be about 5 percent of total available mandays. A split of direct and overhead overtime, however, was not readily available.

Table 25, which are not reflected in the other ratio. Despite these differences, consistent application of either ratio will help focus management attention on significant shifts in the application of labor.

b. <u>Relationship of Shipwork Mandays to Total Direct Mandays</u>

The second indicator summarized in Table 25 was selected to provide a gross indication of the relationship between the number of direct labor mandays expended to accomplish ship-related work and the total number of direct mandays expended to accomplish all work.[1] Since shipwork is the primary workload in naval shipyards, significant shifts in its level may be indicative of potential areas for further study by management. In general, the data show that shipwork comprises from 80 to 90 percent of the total shipyard workloads, with a gradual rise in recent years. Within this limited range, Long Beach, Pearl Harbor, and Norfolk have a somewhat higher percentage of shipwork than the other yards. Philadelphia and Portsmouth are lower. One explanation of this variation is the proximity of the shipyard to a home port. Yards closer to fleet home ports receive larger amounts of emergent shipwork.[2]

The shipwork-to-total-direct ratio is useful to identify significant shifts in the relationship of ship to non-shipwork within an individual shipyard. It is of considerably less value as a basis for comparing shipyards since the amount of shipwork accomplished is not a measure of efficiency.

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[1]Shipwork is defined broadly as work that can be identified to a specific ship by hull numbers. It is a major classification of the work categories defined in the NIF cost accounting system. Because of its broad definition, there is some room for interpretation in classifying certain work. For example, considerable judgment might be involved in classifying work on an item to be used on some ship in the foreseeable future.

[2]Emergent work is basically unscheduled, short lead time ship repair work that normally requires the ship to remain in the shipyard for only a short period of time.

c. <u>Relationship of Direct Mandays Expended by Production Centers to Total Direct Mandays</u>

The third indicator summarized in Table 25 was selected to provide a gross indication of the proportion of the total direct labor expended by naval shipyards that is contributed by the production cost centers.[1] Thus, some insight is provided into the source of the mandays charged to customers. As shown, the production centers account for about 90 percent of the direct effort in naval shipyards with little change since FY-70.

Despite the fact that the NIF has a highly standardized cost accounting system, differences in interpretation, especially at the lower levels of detail, are possible. As a result, differences in charging labor and costs can occur. This performance indicator provides one means of identifying these differences. Significant shifts in these ratios are most likely indicative of changes in cost accounting practices rather than in actual application of labor. Nevertheless, these shifts should be evaluated to ensure that other reasons are not causing the change.

d. <u>Relationship of Direct Mandays Expended by Production Department Productive Shops to Total Direct Mandays</u>

The final ratio summarized in Table 25 reflects the relationship of the number of direct mandays expended by the Production Department Productive Shops to the total direct mandays expended. This ratio is similar to the preceding ratio, except that it considers only those direct mandays expended by the primary, waterfront work force of naval shipyards--the Production Department Productive Shops. For this reason, this ratio is of significant interest to shipyard management.

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[1]In general, cost centers are used in the NIF cost accounting system to facilitate identification of the use of resources to the work accomplished. The production cost centers are those engaged primarily in direct work for customers. See Appendix N for a more detailed discussion of cost centers.

As with previous ratios, the primary value of this ratio is to identify significant trends in the ratio for each shipyard over the time span displayed.[1] As shown in Table 25, the levels for individual shipyards vary by one or two percentage points over the three-year period shown. There is considerable range, however, among yards. From a level of about 64 at Portsmouth, the ratios range into the 80's at Norfolk, Pearl Harbor, and Long Beach. It is worth repeating that these differences reflect differences in management approach to the application of labor rather than differences in efficiency. Consequently, comparing the yards on the basis of these ratios can be extremely misleading.

3. Cost Performance Indicators

The cost of accomplishing assigned workloads is of prime importance in the operation of naval shipyards, for several reasons. First, for the period from FY-70 through FY-74, naval shipyards incurred a cost of approximately $1.2 billion each year in performing work for their customers.[2] This amount represents a significant portion of the total Navy budget. Second, since naval shipyards operate on a break-even basis, the costs incurred by the yards are essentially the same as those billed to customers. To the customer, the cost of work performed is the ultimate effectiveness measure, assuming that quality work is accomplished on schedule. Finally, although costs incurred are not measures of either effectiveness or efficiency, they do provide a meaningful basis for trend analysis. Significant shifts in costs incurred are indicative

[1]Summary data at the shop level were not routinely available prior to FY-72; hence, ratios are computed for a three-year span only.

[2]Total costs incurred, in current year dollars, ranged from $1.3 billion in FY-70 to $1.2 billion in FY-74 with very little variation for each year of this period. Expressed in terms of FY-74 dollars, however, the costs incurred in FY-74 were approximately 70 percent of the FY-70 level.

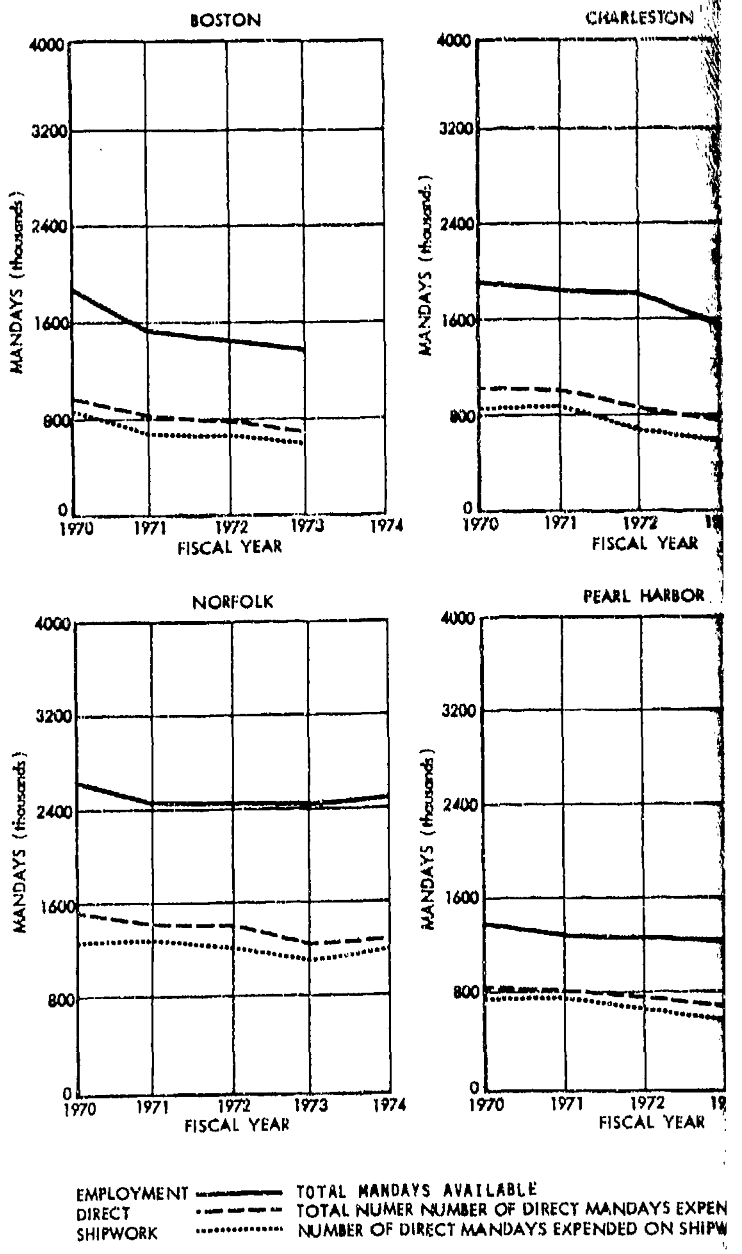
Data Table
(Mandays in Millions)

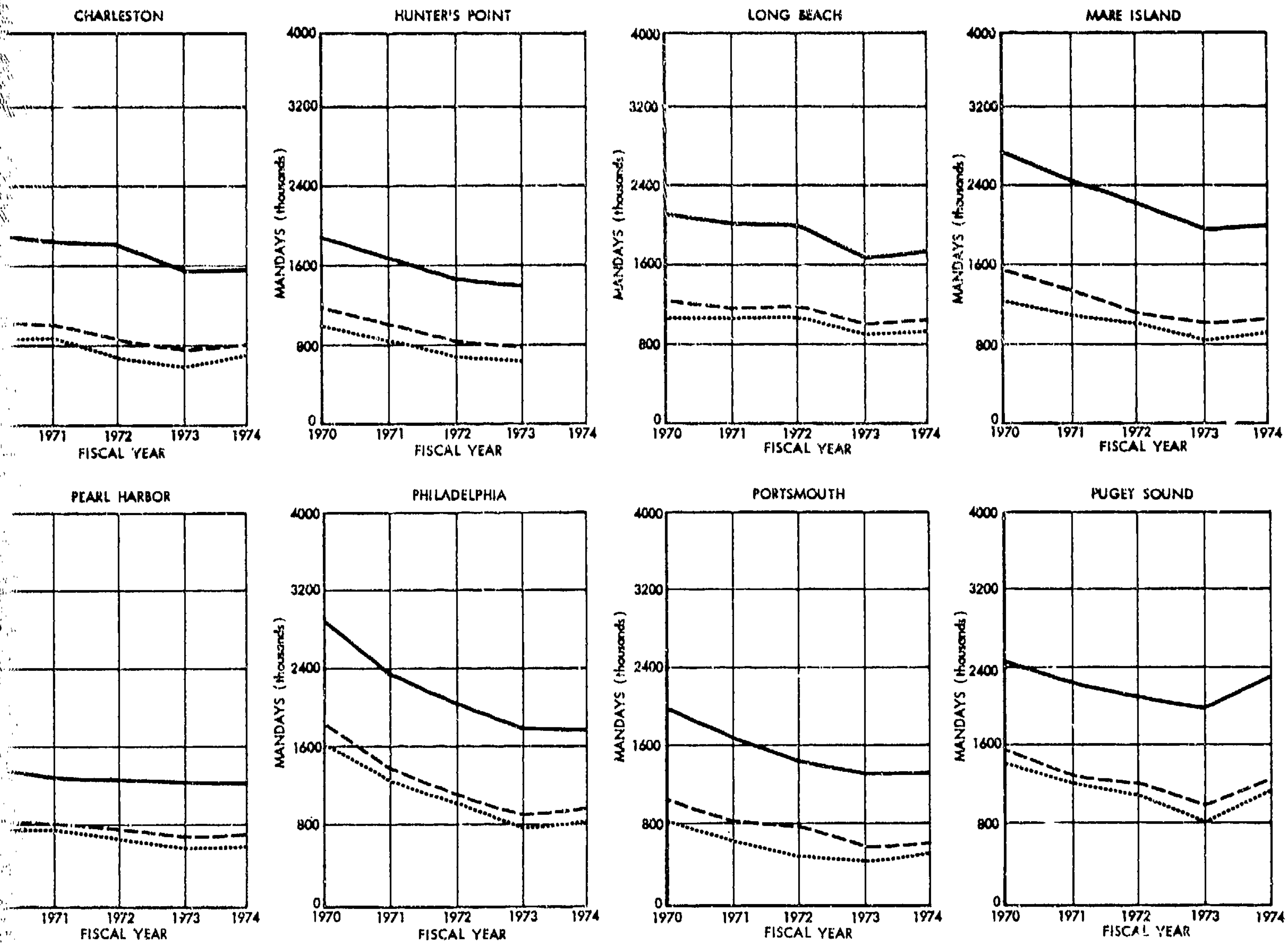
	FY70	FY71	FY72	FY73	FY74[2]
Boston					
Total Available[1]	1.82	1.54	1.44	1.29	*
Total Direct Expended	.99	.80	.79	.68	*
Total Shipwork	.87	.63	.62	.54	*
Charleston					
Total Available	1.89	1.78	1.73	1.59	1.59
Total Direct Expended	1.05	.99	.85	.78	.82
Total Shipwork	.86	.85	.69	.64	.71
Hunters Point					
Total Available	1.83	1.64	1.45	1.39	*
Total Direct Expended	1.16	.95	.81	.77	*
Total Shipwork	1.03	.86	.69	.66	*
Long Beach					
Total Available	1.86	1.80	1.80	1.67	1.77
Total Direct Expended	1.22	1.17	1.16	1.00	1.06
Total Shipwork	1.10	1.05	1.03	.91	.95
Mare Island					
Total Available	2.83	2.43	2.19	1.92	1.99
Total Direct Expended	1.53	1.33	1.15	.98	1.07
Total Shipwork	1.19	1.14	.97	.80	.92
Norfolk					
Total Available	2.60	2.44	2.44	2.35	2.46
Total Direct Expended	1.50	1.41	1.39	1.24	1.31
Total Shipwork	1.31	1.28	1.25	1.12	1.18
Pearl Harbor					
Total Available	1.41	1.31	1.32	1.24	1.23
Total Direct Expended	.88	.83	.78	.68	.70
Total Shipwork	.79	.76	.70	.60	.64
Philadelphia					
Total Available	2.88	2.34	2.04	1.82	1.78
Total Direct Expended	1.75	1.37	1.04	.94	1.00
Total Shipwork	1.61	1.22	.83	.76	.84
Portsmouth					
Total Available	1.91	1.67	1.47	1.36	1.37
Total Direct Expended	1.03	.83	.75	.64	.67
Total Shipwork	.84	.66	.56	.49	.53
Puget Sound					
Total Available	2.47	2.27	2.76	1.98	2.32
Total Direct Expended	1.54	1.31	1.24	1.01	1.32
Total Shipwork	1.43	1.19	1.14	.88	1.20

[1]This term is used to indicate the total mandays available at each shipyard as a function of the average annual employment level.

[2]The asterisk indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years and were not considered in this analysis.

Source: See Table 24.





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DIRECT MANDAYS EXPENDED IN THE SHIPYARD
AYS EXPENDED ON SHIPWORK

Figure 35. MANDAY LEVELS FOR NAVAL SHIPYARDS FOR FY-70 THROUGH FY-74: TOTAL AVAILABLE, TOTAL DIRECT, TOTAL SHIPWORK

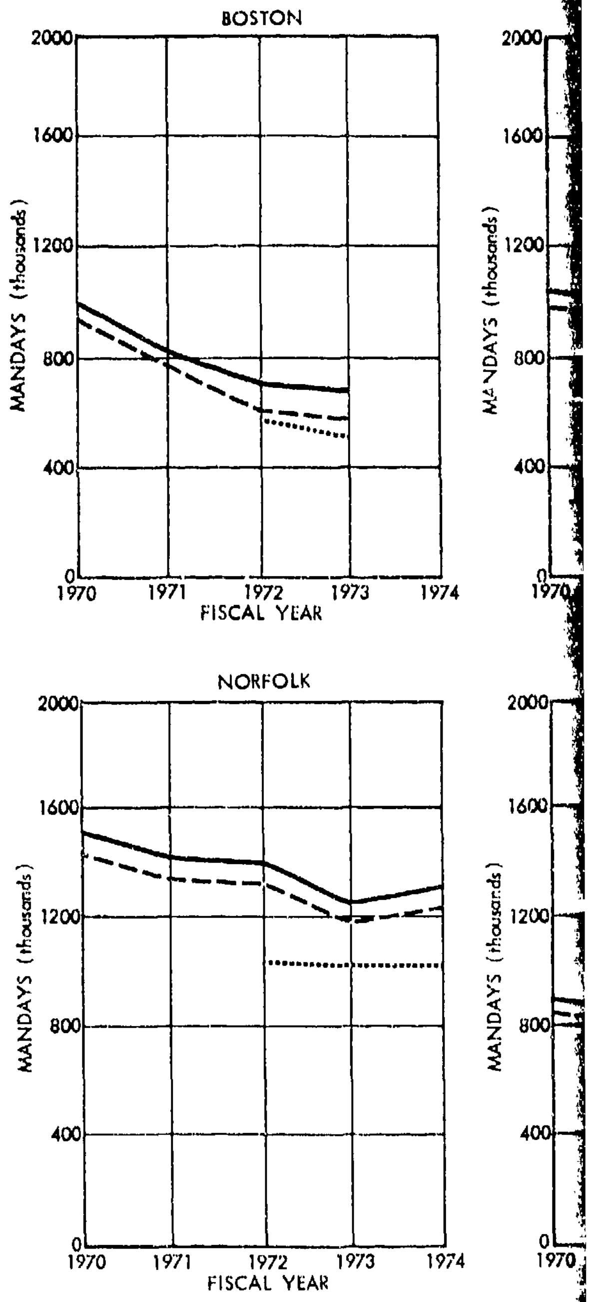
Data Table
(Mandays in Millions)

	FY70[1]	FY71[1]	FY72	FY73	FY74[2]
Boston					
Total Direct Expended	.99	.80	.79	.68	*
Total by all Productive Centers	.92	.71	.68	.59	*
Total by Productive Shops Only			.58	.51	*
Charleston					
Total Direct Expended	1.05	.99	.85	.78	.82
Total by all Productive Centers	.97	.93	.80	.72	.76
Total by Productive Shops Only			.64	.57	.60
Hunters Point					
Total Direct Expended	1.16	.95	.81	.77	*
Total by all Productive Centers	1.11	.92	.78	.74	*
Total by Productive Shops Only			.69	.66	*
Long Beach					
Total Direct Expended	1.22	1.17	1.16	1.00	1.06
Total by all Productive Centers	1.17	1.11	1.11	.97	1.02
Total by Productive Shops Only			.99	.86	.90
Mare Island					
Total Direct Expended	1.53	1.33	1.15	.98	1.07
Total by all Productive Centers	1.43	1.24	1.09	.92	1.00
Total by Productive Shops Only			.79	.68	.76
Norfolk					
Total Direct Expended	1.50	1.41	1.39	1.24	1.31
Total by all Productive Centers	1.41	1.34	1.30	1.16	1.24
Total by Productive Shops Only			1.12	1.01	1.09
Pearl Harbor					
Total Direct Expended	.88	.83	.78	.68	.70
Total by all Productive Centers	.85	.80	.76	.64	.66
Total by Productive Shops Only			.63	.53	.55
Philadelphia					
Total Direct Expended	1.75	1.37	1.04	.94	1.00
Total by all Productive Centers	1.66	1.26	.93	.83	.90
Total by Productive Shops Only			.79	.71	.78
Portsmouth					
Total Direct Expended	1.03	.83	.75	.64	.67
Total by all Productive Centers	.94	.75	.64	.55	.57
Total by Productive Shops Only			.47	.41	.43
Puget Sound					
Total Direct Expended	1.54	1.31	1.24	1.01	1.32
Total by all Productive Centers	1.44	1.21	1.16	.94	1.24
Total by Productive Shops Only			.91	.73	.97

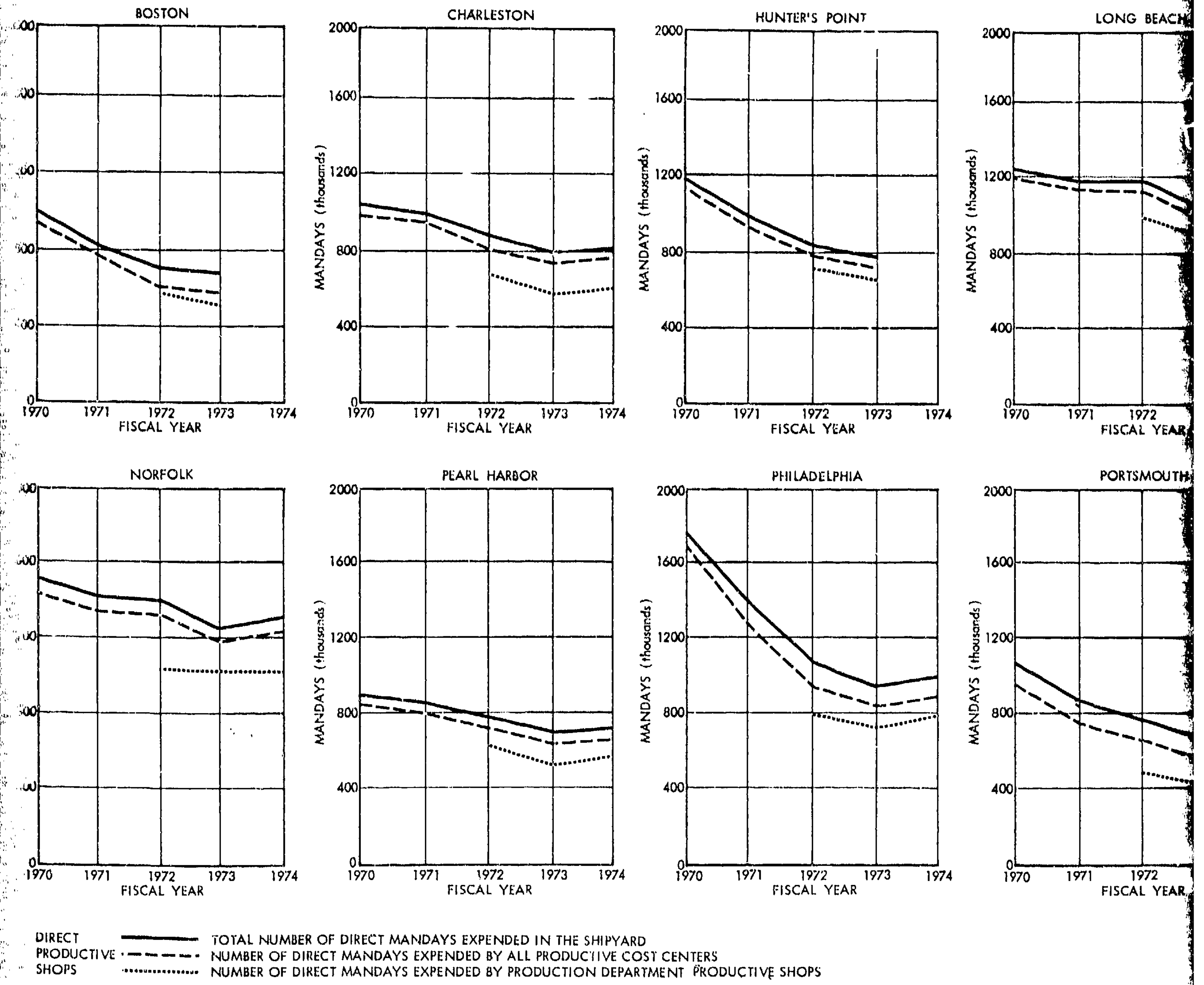
[1]Total for all productive shops not provided for FY-70 and FY-71.

[2]The asterisk indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years and were not considered in this analysis.

Source: See Table 24.



DIRECT — TOTAL NUMBER OF DIRECT
PRODUCTIVE — NUMBER OF DIRECT MAND
SHOPS — NUMBER OF DIRECT MAND



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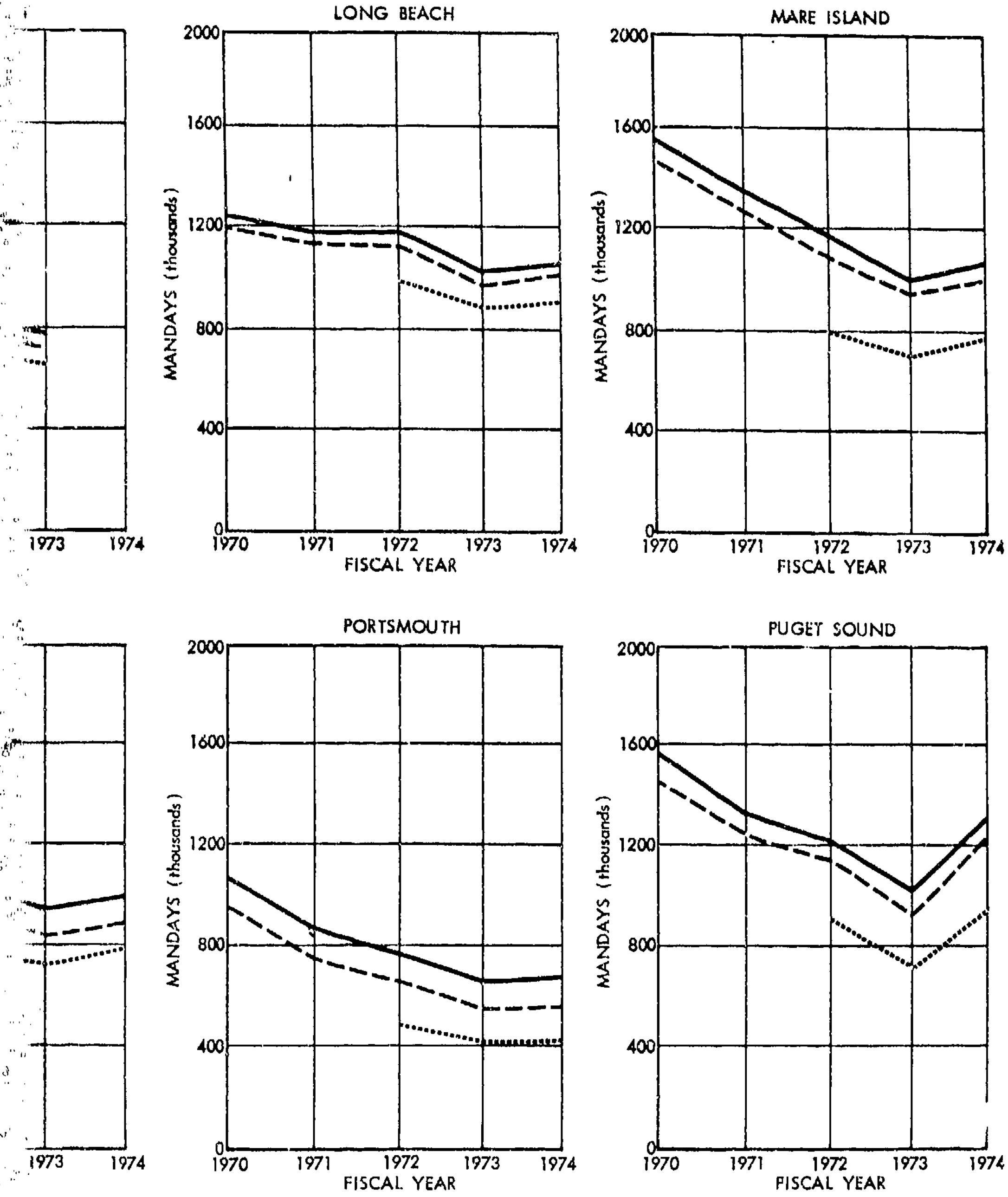

Figure 36. MANDAY LEVELS FOR NAVAL SHIPYARDS FOR FY-70 THROUGH FY-74: TOTAL DIRECT, TOTAL BY PRODUCTIVE CENTERS, TOTAL BY ALL SHOPS

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of changes in the application of all input resources and, thus, focus management attention on opportunities to increase the overall efficiency and effectiveness of the operation without measuring either factor in absolute terms. For these reasons, cost indicators are considered essential to the evaluation of the overall performance of naval shipyards.

As with the labor ratios, cost indicators take many forms. For this study, the form selected is the ratio of the costs incurred by each shipyard to the total direct labor expended in accomplishing assigned workloads. To facilitate comparative analysis, all costs were converted to a manday basis, in constant dollars. Ratios were computed using total costs to provide insight into overall trends. Additional ratios were computed at lower levels of detail to focus attention on important cost considerations. In all, a total of six ratios were computed in two major groups:

- Cost per direct manday expended by major cost category (direct and overhead).
- Cost per direct manday expended by major cost element (labor, material and "other").

These two groups of ratios are discussed separately below. The data used to compute the ratios are presented, in tabular and graphical form, in fold-outs at the end of the section to facilitate reference (see Figures 37 and 38).

Although cost-per-manday ratios are useful for monitoring trends in the application of input resources in naval shipyards, they also have the limitations discussed earlier for other performance indicators. Thus, after establishing the basis on which the ratios are computed, they should be used primarily for trend analysis.

a. <u>Cost-Per-Manday Ratios by Major Cost Category</u>

As pointed out in the discussion of labor ratios, employment levels and the number of direct mandays expended in naval

shipyards have declined steadily in recent years. Over this same period, the total costs incurred by the naval shipyards in support of customers have remained fairly level when expressed in current year dollars. The net effect of these two trends is that cost per direct manday has increased over the period such that the FY-74 value was 42 percent higher than the FY-70 value. Expressed in terms of FY-74 dollars, however, this cost has shown only a small increase.

Cost-per-direct manday data by total, direct, and overhead categories for individual shipyards are presented in Figure 37. The ratios computed from these data are presented in Table 27.

As shown by Figure 37, the total costs per manday for the individual yards exhibit a general rise over the time span displayed, except for FY-74.[1] In FY-74, some of the yards exhibit slight decreases due to the adjusments related to the closures of Boston and Hunter's Point Naval Shipyards. The largest decrease in cost per direct manday occurred at Puget Sound due to the previously discussed large increase in direct mandays expended. Spreading total costs over this proportionately larger base accounts for the overall increase in cost per direct manday.

Table 27 provides three cost-per-direct manday ratios that were developed to facilitate the identification of significant shifts in the relation of direct, overhead, and total costs. Although these ratios are best used to monitor changes over time in individual shipyards, generalizations are possible in terms of overall trends. First, overhead costs account for

[1]The Navy routinely publishes data on the repair cost per manday in the quarterly *SONS*. Corresponding numbers in this section are somewhat higher since all work categories are considered. The level at which manday cost data will be most useful will depend on the problem of interest. For example, cost per manday for only non-shipwork could be readily computed from data available in the *F&O Statements* if the amount and cost of non-shipwork are areas of concern.

Table 27. SELECTED COST PER MANDAY RATIOS FOR NAVAL SHIPYARDS

(By major cost category)

Shipyard	Ratio				
	FY70	FY71	FY72	FY73	FY74[1]
			DIRECT TO TOTAL		
Boston	.63	.60	.61	.61	*
Charleston	.60	.58	.55	.56	.56
Hunters Point	.68	.65	.65	.65	*
Long Beach	.68	.68	.68	.68	.65
Mare Island	.62	.63	.63	.62	.59
Norfolk	.62	.60	.62	.60	.57
Pearl Harbor	.65	.62	.59	.60	.60
Philadelphia	.66	.63	.61	.63	.62
Portsmouth	.62	.60	.60	.58	.56
Puget Sound	.67	.64	.61	.59	.62
			OVERHEAD TO TOTAL		
Boston	.37	.40	.39	.39	*
Charleston	.40	.42	.45	.44	.44
Hunters Point	.32	.35	.35	.35	*
Long Beach	.32	.32	.32	.32	.35
Mare Island	.38	.37	.37	.38	.41
Norfolk	.38	.40	.38	.40	.43
Pearl Harbor	.35	.38	.41	.40	.40
Philadelphia	.34	.37	.39	.37	.38
Portsmouth	.38	.40	.40	.42	.44
Puget Sound	.33	.36	.39	.41	.38
			OVERHEAD TO DIRECT		
Boston	.58	.66	.65	.64	*
Charleston	.67	.72	.83	.79	.79
Hunters Point	.47	.53	.55	.54	*
Long Beach	.46	.48	.47	.47	.55
Mare Island	.61	.59	.60	.61	.68
Norfolk	.61	.65	.61	.67	.75
Pearl Harbor	.55	.62	.68	.68	.66
Philadelphia	.50	.59	.63	.59	.62
Portsmouth	.62	.67	.67	.73	.80
Puget Sound	.48	.57	.64	.69	.62

[1]The asterisk in column FY74 indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years. Hence, these ratios were not computed.

Source: Derived from data in Figure 37.

approximately 35 to 40 percent of the total cost per manday. Second, the ratio exhibits a gradual increase over the time period for which data are shown. This increase is quite evident in FY-74 and is contrary to what would normally be expected in the yards that remained open after two yards were closed and workloads redistributed. Although many variables are involved, this trend should cause management to examine in depth the impact of the closure actions.[1]

b. Cost-Per-Manday Ratios by Major Cost Element

Cost-per-direct manday data by labor, material, and "other" cost elements for individual shipyards are presented, in tabular and graphical form, in Figure 38. The ratios computed from these data are presented in Table 28.

As shown by Figure 38, labor accounts for roughly 75 percent of the total manday cost. This substantiates the generally accepted tenet that ship repair is a labor-intensive industrial activity. Material costs generally account for about 15 percent of total manday costs, and the balance is accounted for by miscellaneous costs included in the "other" cost element.

The ratios presented in Table 28 were selected to facilitate the monitoring of shifts in the relative costs of the three types of resource inputs.

4. Miscellaneous Indicators

The discussion about performance indicators to this point has focused on labor and cost ratios. These two groups of indicators may be considered of primary importance because they focus attention on the overall performance of shipyards. This

[1]It may still be too early to evaluate the true impact of the FY-74 closure actions. On the surface, however, overhead costs would be expected to decrease as the result of lower fixed overhead expenses. It may be that this decrease occurred but was more than offset by other factors that determine total overhead costs.

Table 28. SELECTED COST PER MANDAY RATIOS FOR NAVAL SHIPYARDS
(By major cost element)

Shipyards	Ratio/Fiscal Years				
	1970	1971	1972	1973	1974[1]
			LABOR TO TOTAL		
Boston	.73	.75	.74	.73	*
Charleston	.76	.76	.76	.76	.75
Hunters Point	.75	.75	.73	.72	*
Long Beach	.70	.71	.71	.68	.71
Mare Island	.75	.73	.71	.73	.75
Norfolk	.72	.73	.68	.69	.73
Pearl Harbor	.73	.78	.71	.74	.73
Philadelphia	.66	.71	.70	.68	.68
Portsmouth	.75	.77	.72	.70	.73
Puget Sound	.75	.79	.81	.81	.78
			MATERIAL TO TOTAL		
Boston	.18	.15	.16	.15	*
Charleston	.15	.15	.16	.16	.16
Hunters Point	.18	.17	.19	.16	*
Long Beach	.22	.21	.21	.23	.18
Mare Island	.19	.17	.16	.15	.14
Norfolk	.21	.19	.21	.19	.17
Pearl Harbor	.22	.18	.17	.21	.19
Philadelphia	.23	.21	.21	.21	.18
Portsmouth	.20	.13	.17	.23	.22
Puget Sound	.18	.16	.13	.12	.15
			"OTHER" TO TOTAL		
Boston	.09	.10	.10	.12	*
Charleston	.09	.09	.08	.08	.09
Hunters Point	.07	.08	.08	.12	*
Long Beach	.08	.08	.08	.08	.11
Mare Island	.06	.10	.13	.12	.11
Norfolk	.07	.08	.11	.12	.10
Pearl Harbor	.05	.10	.12	.05	.08
Philadelphia	.11	.08	.09	.11	.14
Portsmouth	.05	.10	.11	.07	.05
Puget Sound	.07	.05	.06	.07	.07

[1]The asterisk in column FY74 indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years. Hence, these ratios were not computed.

Source: Derived from data in Figure 38.

section addresses several indicators reviewed during the preparation of this paper that are considered to be of secondary importance. They are presented as illustrative of the kind of indicators that could be derived for the special analyses of areas of concern identified by the primary indicators. All of the secondary indicators involve characteristics of the shipyard work force.

Employees in naval shipyards may be divided into two groups based on personnel classification and pay systems. The largest group, the wage employees, constitutes over 75 percent of total shipyard employment. This group comprises employees in the trade, labor, and craft job categories. The remaining group includes the general-schedule employees, those in the clerical, administrative, technical, and professional job categories.[1]

Part A of Table 29 summarizes employment levels for all naval shipyards for FY-70 through FY-74. As shown, total employment has declined gradually over the period, and the end-FY-74 level was approximately 73 percent of the end-FY-70 level. Part B of the table provides two relationships involving shipyard wage employees. Since this group comprises the basic "water-front" capability of the shipyards, these ratios are of special interest to shipyard management. Line B-1 shows the ratio of the total number of wage employees to total yard employees. Despite the overall decline in total employment, the percentage of wage employees has remained relatively constant at approximately 75 percent. Line B-2 shows the ratio of total wage employees at step three or above to the total number of wage employees. This ratio has remained over 75 percent

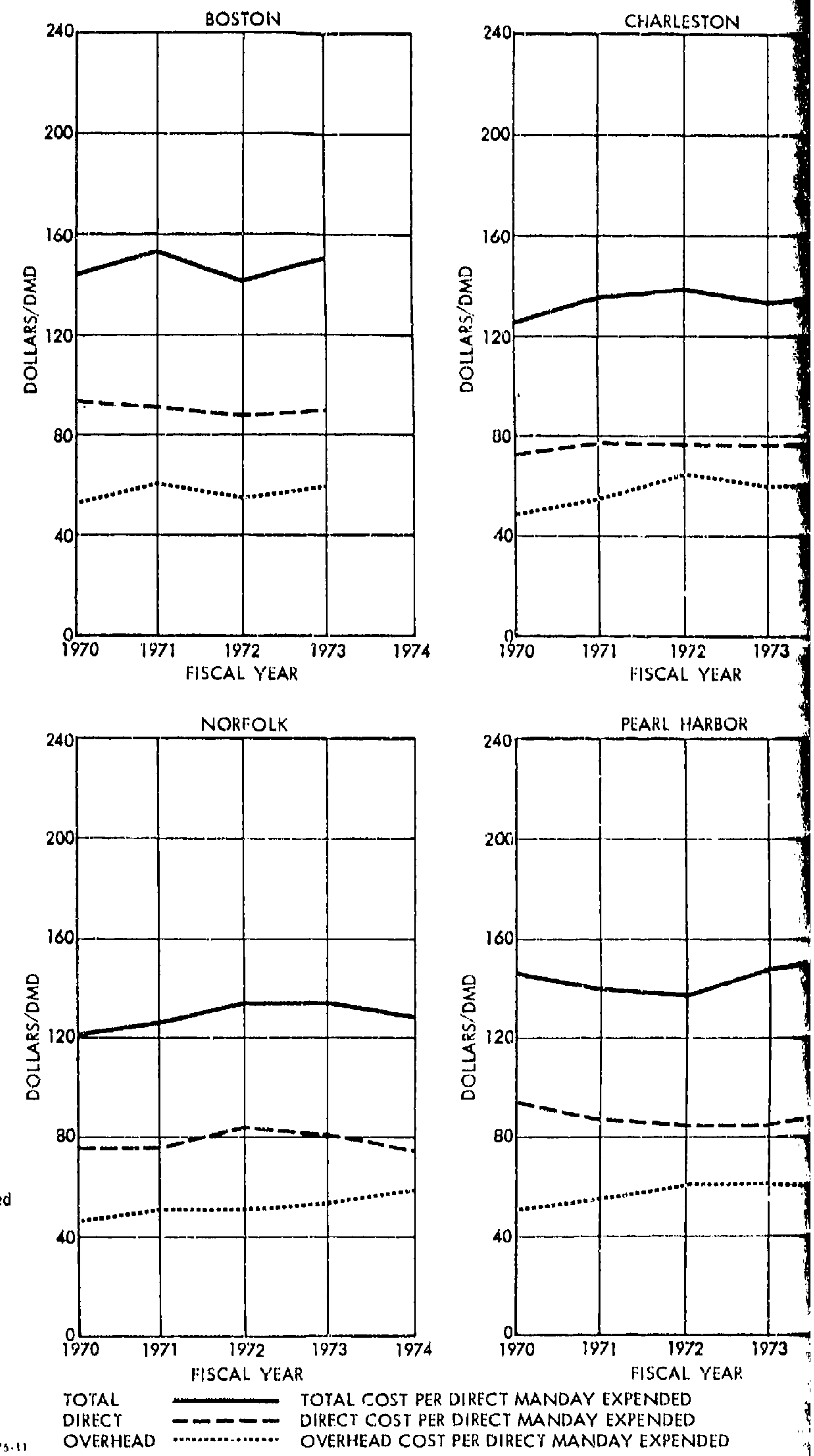
[1]These two groups are alternatively referred to as blue and white collar workers, respectively. In addition, they are sometimes referred to, erroneously, as direct and overhead workers. This labeling can be misleading since, under NIF procedures, individuals are charged as direct or overhead workers on the basis of work performed rather than position. See Appendix O for a more detailed discussion of these two groups.

Data Table

	Fiscal Year				
	1970	1971	1972	1973	1974[1]
Boston					
Direct	96.10	95.48	89.56	94.99	*
Overhead	55.81	62.63	57.97	60.51	*
Total	*151.91*	*158.10*	*147.53*	*155.50*	*
Charleston					
Direct	77.82	79.81	78.95	79.46	79.76
Overhead	52.51	57.37	65.78	63.16	63.36
Total	*130.32*	*137.19*	*144.73*	*142.61*	*143.11*
Hunters Point					
Direct	123.89	127.38	120.84	137.54	*
Overhead	58.32	67.32	65.98	73.73	*
Total	*182.21*	*194.70*	*186.83*	*211.27*	*
Long Beach					
Direct	85.44	83.85	85.33	91.95	86.27
Overhead	39.51	39.87	40.24	43.33	47.21
Total	*124.95*	*123.71*	*126.57*	*135.29*	*133.48*
Mare Island					
Direct	97.79	100.61	102.96	100.21	99.05
Overhead	59.67	59.47	61.52	61.37	67.59
Total	*157.46*	*160.08*	*164.48*	*161.58*	*166.64*
Norfolk					
Direct	79.34	79.30	85.68	83.66	76.35
Overhead	48.51	51.83	52.60	55.66	57.60
Total	*127.85*	*131.13*	*138.28*	*139.32*	*133.95*
Pearl Harbor					
Direct	96.57	88.58	88.25	93.90	94.55
Overhead	52.76	55.05	60.35	63.87	62.71
Total	*149.33*	*143.63*	*148.60*	*157.78*	*157.26*
Philadelphia					
Direct	98.38	89.14	89.68	88.14	94.18
Overhead	49.63	52.55	56.21	51.95	58.78
Total	*148.02*	*141.69*	[illegible]	*140.09*	*152.96*
Portsmouth					
Direct	80.89	82.67	87.77	89.54	85.16
Overhead	50.37	55.79	58.86	65.70	68.02
Total	*131.26*	*138.46*	*146.63*	*155.24*	*153.18*
Puget Sound					
Direct	99.41	96.49	89.70	92.44	82.39
Overhead	48.11	55.11	57.14	63.76	50.72
Total	*147.53*	*151.6*	*146.83*	*156.20*	*133.11*

[1]The asterisk indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years and were not considered in this analysis.

Source: See Table 24.



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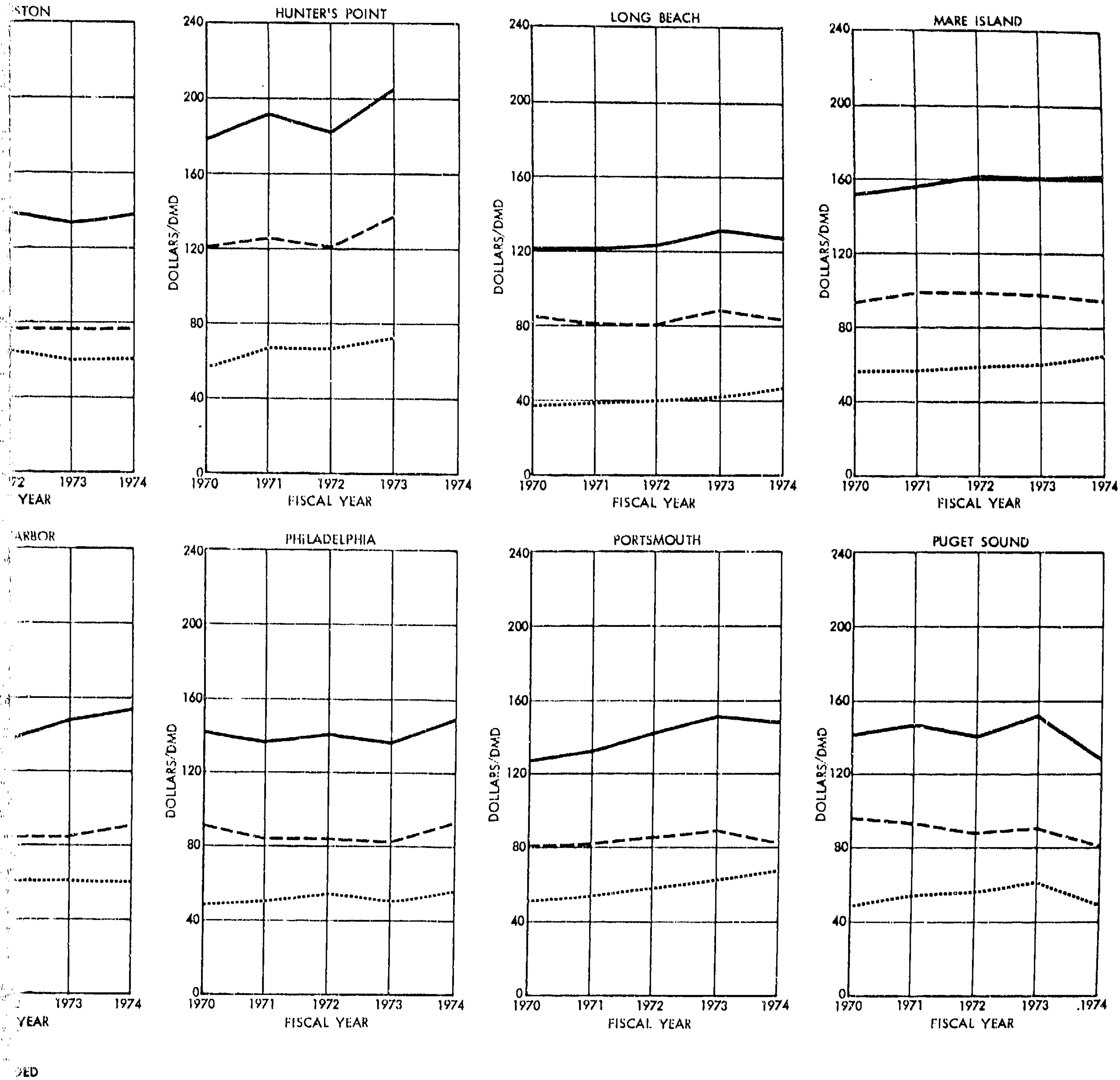


Figure 37. COST PER DIRECT MANDAY IN NAVAL SHIPYARDS BY MAJOR COST CATEGORY FOR FY-70 THROUGH FY-74

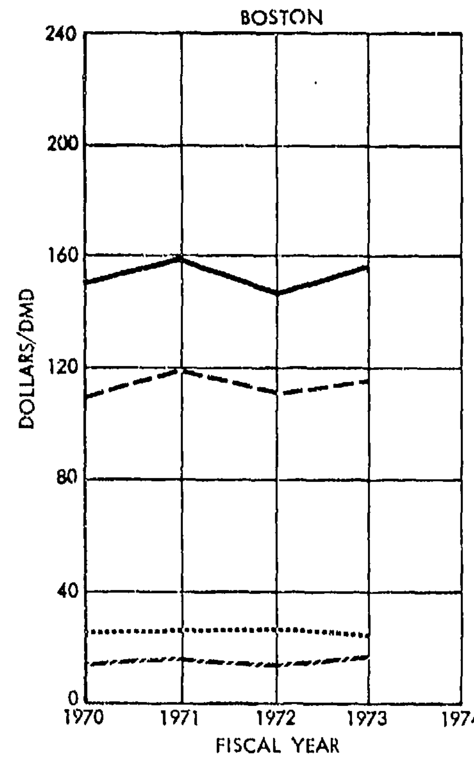
(Constant FY-74 Dollars)

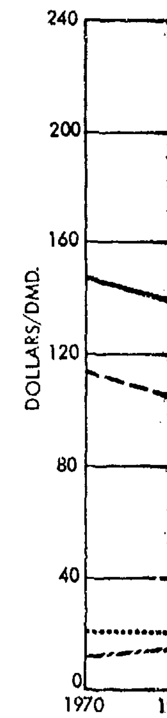
Data Table

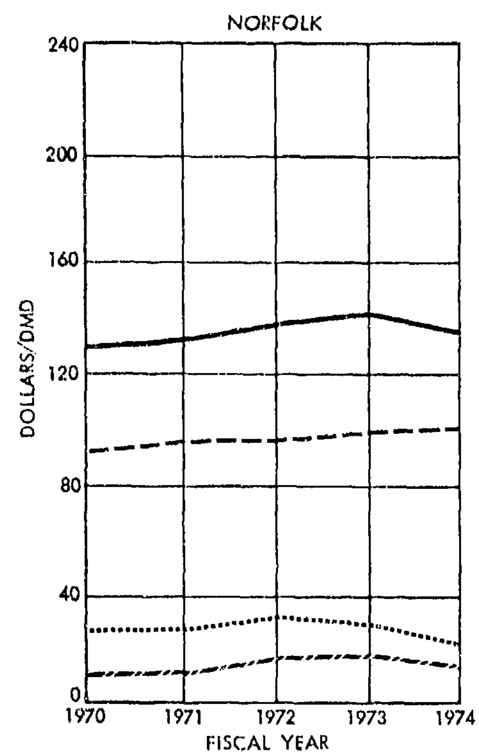
	Fiscal Year				
	1970	1971	1972	1973	1974[1]
Boston					
Labor	111.40	118.79	109.49	113.89	*
Material	26.91	24.05	24.25	23.74	*
Other	13.60	15.26	13.78	17.87	*
Total	*161.91*	*158.10*	*147.53*	*155.50*	*
Charleston					
Labor	99.65	103.85	109.48	108.58	107.99
Material	19.47	20.86	23.07	22.50	22.59
Other	11.20	12.47	12.18	11.54	12.54
Total	*130.33*	*137.19*	*144.73*	*142.61*	*143.11*
Hunters Point					
Labor	136.97	145.92	136.56	152.94	*
Material	32.02	32.59	34.80	33.23	*
Other	13.22	16.19	15.47	25.11	*
Total	*183.21*	*194.70*	*186.83*	*211.27*	*
Long Beach					
Labor	87.26	87.88	89.12	91.43	94.40
Material	27.71	26.12	25.90	30.02	23.87
Other	9.97	9.71	10.55	13.84	15.20
Total	*124.95*	*123.71*	*125.57*	*135.29*	*133.48*
Mare Island					
Labor	117.80	117.16	117.44	117.92	125.04
Material	29.95	26.78	27.18	24.21	22.58
Other	9.72	16.13	19.85	19.45	19.01
Total	*157.46*	*160.08*	*164.48*	*161,58*	*166.64*
Norfolk					
Labor	91.91	95.61	94.52	95.61	97.39
Material	26.52	24.86	29.07	27.06	22.56
Other	9.42	10.67	14.69	16.65	14.00
Total	*127.85*	*131.13*	*138.28*	*139.32*	*133.95*
Pearl Harbor					
Labor	109.55	112.69	114.81	116.00	114.62
Material	32.52	25.96	25.30	33.37	30.41
Other	7.26	4.98	8.49	8.34	12.23
Total	*149.33*	*143.63*	*148.60*	*157.78*	*157.26*
Philadelphia					
Labor	97.05	99.94	102.55	94.97	104.51
Material	34.56	28.95	30.49	29.93	27.71
Other	16.40	12.79	12.85	15.19	20.74
Total	*148.02*	*141.68*	*145.89*	*140.09*	*152.96*
Portsmouth					
Labor	98.99	106.31	105.12	108.5	111.33
Material	25.63	16.92	25.13	36.17	33.30
Other	6.64	15.23	16.38	10.57	8.55
Total	*131.26*	*138.46*	*146.63*	*155.24*	*153.18*
Puget Sound					
Labor	110.23	119.2	119.79	127.18	104.23
Material	27.17	24.09	19.11	19.25	19.67
Other	10.13	8.31	7.94	9.78	9.21
Total	*147.53*	*151.6*	*146.83*	*156.20*	*133.11*

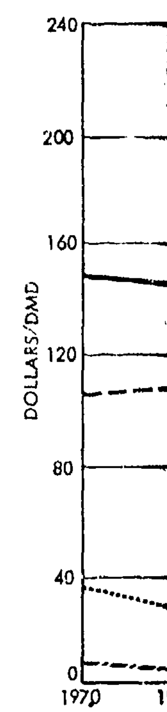
[1]The asterisk indicates that due to closure action, data for Boston and Hunter's Point were not consistent with earlier years and were not considered in this analysis.

Source: See Table 24.









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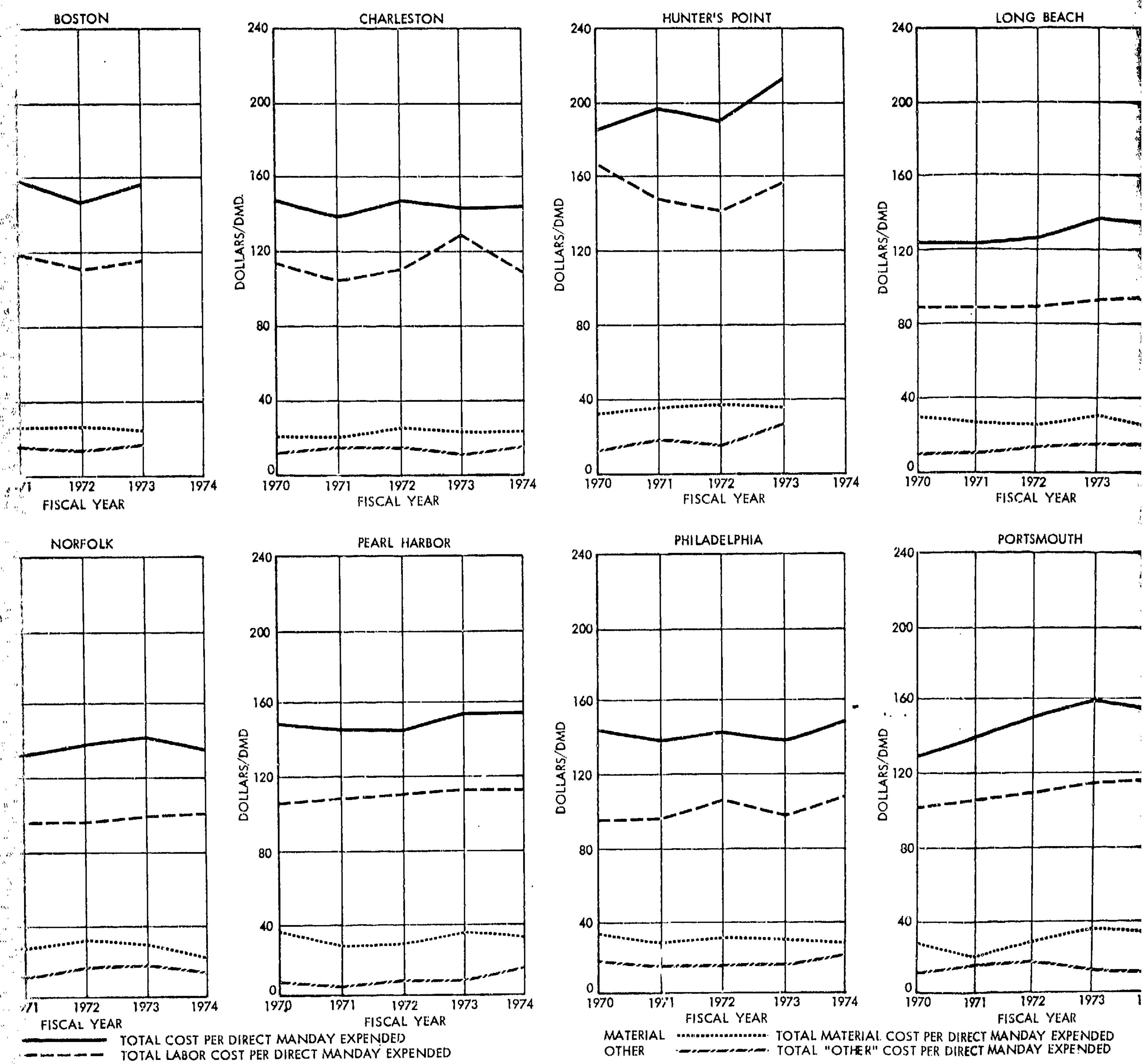

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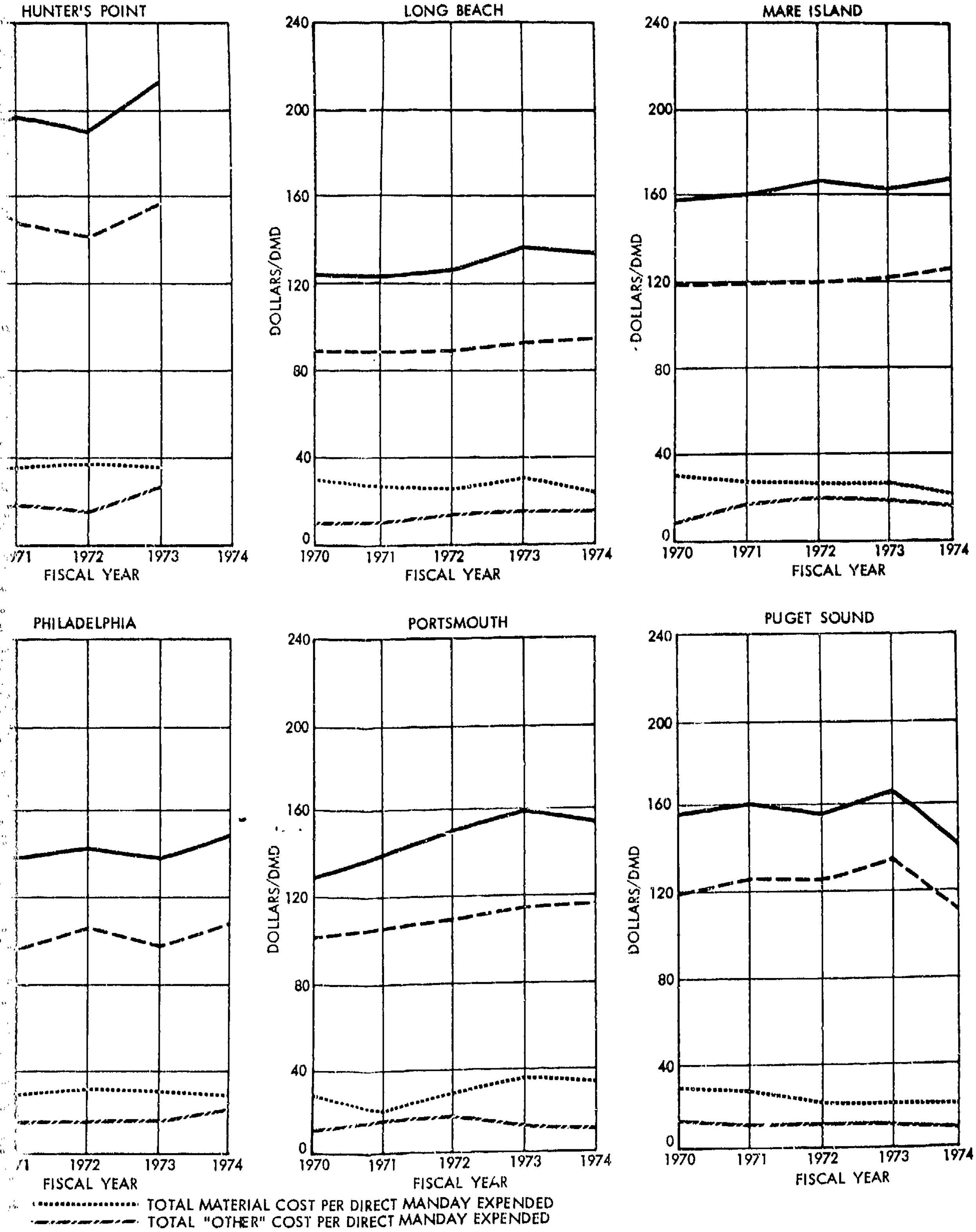

Figure 38. COST PER DIRECT MANDAY IN NAVAL SHIPYARDS BY MAJOR COST ELEMENT FOR FY-70 THROUGH FY-74

(Constant FY-74 Dollars)

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Table 29. NUMBER OF EMPLOYEES AND SELECTED PERSONNEL RATIOS SUMMARY: ALL NAVAL SHIPYARDS

	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974
A. NUMBER OF EMPLOYEES[1]					
1. General Schedule Employees	19,290	17,985	16,115	13,484	13,959
2. Wage Employees	62,700	54,332	49,969	42,615	46,025
3. *Total Shipyard Employees*	*81,990*	*72,317*	*66,084*	*56,099*	*59,984*
B. EMPLOYEE RATIOS					
1. Number of Wage Employees to Total Shipyard Employees	76.5	75.1	75.6	80.0	76.7
2. Number of Wage Employees at Step Three and Above to Total Number of Wage Employees[2]	77.7	78.7	83.1	77.0	78.4

[1]Employment data reflect levels as of 30 June for each fiscal year shown, as extracted from NAVSEAs *Statistics of Naval Shipyards*.

[2]Number of wage employees at step three and above extracted from the Revenue and Cost Statement in the *Financial and Operating Statements* as of 30 June for each fiscal year shown.

for the entire period shown. Wage employees receive a 4 percent increase in pay between steps, and advancement to the next higher step is automatic; hence, this ratio is important in assessing the effect of the Federal Wage System on the cost of labor in naval shipyards. This subject will be discussed further in Chapter V.

Table 30 summarizes selected skill and functional relationships within the wage employee group.[1] These ratios are not measures of the efficiency of the labor force but merely show key relationships that can be assumed to influence the overall contributions of labor to output. Thus, these ratios can be used to identify trends within a shipyard that might affect the overall efficiency of the labor force.

Tables 31 and 32 summarize civilian employment data for general-schedule and wage workers, respectively. These tables were prepared to provide some insight into the age and length-of-service of shipyard workers.[2] Two important characteristics of the work force are stressed:

- The percentage of employees with less than four years service--a gross indicator of the experience level in each shipyard.
- The percentage of employees either eligible for retirement or within five years of eligibility--an indicator of the number of employees who may have to be replaced in the near future.

As shown by the tables, about 20 percent of the employees in naval shipyards have less than four years service. Coincidently,

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[1]Most of the group titles are self-explanatory except, perhaps, for "Journeymen." This group consists of skilled mechanics within each craft in the shipyard. As used by the Civil Service Commission (CSC), it includes mechanics in wage grades WL and WG-9 through 15 (see Appendix O).

[2]Note that these tables reflect total shipyard employment of about 63,000 as of 31 December 74 versus and end-FY-74 level of about 60,000 and an authorized end-FY-75 level of about 61,500. The additional workers are temporary employees hired to meet projected workloads during the year. The Navy has authority to plan for the use of additional temporary employees as long as end-year control totals are met.

Table 30. SELECTED RATIOS FOR NAVAL SHIPYARD WAGE EMPLOYEES (FY-70 Through FY-74)

Ratio	Fiscal Year 1970	1971	1972	1973	1974
JOURNEYMEN TO SUPERVISORS					
Portsmouth	8.14	8.26	6.71	9.15	7.82
Philadelphia	8.85	10.00	9.33	10.09	9.42
Norfolk	11.20	8.24	8.77	9.19	7.80
Charleston	8.07	8.16	8.32	8.45	6.70
Long Beach	7.80	9.62	8.93	8.67	9.24
Mare Island	7.35	6.71	6.66	6.85	7.00
Puget Sound	8.60	7.29	7.25	7.38	7.17
Pearl Harbor	9.05	8.43	6.54	8.61	8.34
ALL	*8.62*	*8.17*	*8.13*	*8.61*	*7.83*
JOURNEYMEN TO HELPERS AND INTERMEDIATE*					
Portsmouth			3.86	7.95	3.47
Philadelphia			3.96	4.21	3.83
Norfolk			3.71	4.06	2.94
Charleston			6.22	5.75	4.96
Long Beach			3.47	3.43	2.55
Mare Island			4.42	5.20	3.07
Puget Sound			5.76	6.49	3.65
Pearl Harbor			4.73	7.57	6.19
ALL			*4.44*	*4.98*	*3.44*
NON-SUPERVISOR TO SUPERVISORS					
Portsmouth	10.29	9.22	10.48	11.06	10.88
Philadelphia	11.47	12.15	13.38	14.04	13.54
Norfolk	14.95	10.69	13.34	14.17	12.21
Charleston	9.94	9.70	10.23	11.71	9.82
Long Beach	10.33	11.93	12.65	12.21	14.01
Mare Island	9.27	8.27	9.28	9.17	10.27
Puget Sound	10.43	8.80	9.57	10.12	10.43
Pearl Harbor	10.98	10.24	8.98	11.35	11.42
ALL	*10.87*	*10.01*	*11.35*	*11.78*	*11.51*

*Not separately identified for FY70 and 71.

Source: Table 4 of NAVSEAs *Statistics of Naval Shipyards*. Data are as of 30 June for each fiscal year shown.

Table 31. CIVILIAN EMPLOYMENT PROFILE BY AGE AND LENGTH-OF-SERVICE, GENERAL-SCHEDULE EMPLOYEES

Naval Shipyard	Percent of Employees for Selected Groups			Total Number Employees
	Less Than Four Years Service--All Ages	Eligible For Retirement[1]	"Near" Eligibles[2]	
Charleston	22.3	9.5	13.3	1,631
Long Beach	17.5	9.8	7.3	1,350
Mare Island	15.9	11.9	4.7	2,255
Norfolk	15.1	15.2	9.2	1,921
Pearl Harbor	16.0	6.8	2.6	1,241
Philadelphia	11.0	21.0	10.2	1,690
Portsmouth	12.2	16.6	9.1	2,266
Puget Sound	22.2	8.1	9.9	2,492
ALL YARDS	16.6	13.5	6.7	14,846

[1]Current Civil Service regulations define retirement eligibility as a combination of age and service as follows: a) 55 with 30 or more years; b) 60 with 20 or more years; c) 65 with 5 or more years.

[2]This group represents those age/service groups within five years of being eligible for retirement.

Source: Derived from computer listing provided by the U.S. Navy, Office of Civilian Manpower Management, March 1975. Data reflect 31 December 1974 position.

Table 32. CIVILIAN EMPLOYMENT PROFILE BY AGE AND LENGTH-OF-SERVICE, WAGE EMPLOYEES

Naval Shipyard	Percent of Employees for Selected Groups			Total Number Employees
	Less Than Four Years Service--All Ages	Eligible for Retirement[1]	"Near" Eligibles[2]	
Charleston	24.0	9.2	15.7	5,399
Long Beach	17.1	7.1	15.4	6,144
Mare Island	19.4	7.0	14.8	7.202
Norfolk	24.1	9.6	16.1	7,921
Pearl Harbor	14.2	6.7	15.8	3,753
Philadelphia	19.0	9.5	18.7	5,581
Portsmouth	18.4	7.6	17.9	4,446
Puget Sound	25.5	3.8	11.0	7,896
All Yards	20.9	7.5	15.4	48,342

[1]Current Civil Service regulations define retirement eligibility as a combination of age and service as follows: a) 55 with 30 or more years; b) 60 with 20 or more years; c) 65 with 5 or more years.

[2]This group represents those age/service groups within five years of being eligible for retirement.

Source: Derived from computer listing provided by the U.S. Navy Office of Civilian Manpower Management, March 1975. Data reflect 31 December 74 position.

about 20 percent of the employees could require replacement within a year it they elected to retire. Of all the yards, it appears that Philadelphia may face the most significant replacement problems--over 31 percent of its general-schedule employees and over 28 percent of its wage employees are within five years of being eligible to retire.

C. IMPROVING OVERALL PERFORMANCE WITHOUT MEASURING IT

The previous section discussed several performance indicators that could be used to monitor the overall performance of naval shipyards. The indicators would identify significant shifts in selected parameters to focus management attention on opportunities to improve the overall performance of operations.

This section carries this concept one step further. Attention is focused on three areas in which positive management action would improve the overall performance of operations without measuring the improvement. Three actions would improve the efficiency of shipyard operations:

- Producing an improved workload-work force match.
- Increasing worker efficiency.
- Reducing the cost of input resources.

Each of these areas will be discussed separately in this section. A fourth action, formal adoption of a concept to evaluate the effectiveness of shipyards, is discussed in Section D. of this chapter.

1. Workload-Work Force Match

A major factor that affects the overall efficiency of industrial operations such as naval shipyards is the extent to which actual day-to-day workloads match employment levels. In this regard, two considerations are of overriding importance. First, long-range workload projections must not only be reasonably accurate but also should contain as few peaks and

valleys as possible. Second, short-run adjustments in workloads or employment levels must be possible if workload projections vary from forecasts. As straightforward as these considerations appear to be, maintaining a desired workload-work force match is difficult for naval shipyards.

The workload-work force match problem in naval shipyards is further complicated by the fact that each shipyard is required to maintain the capability to respond to a broad range of support requirements. Each shipyard is designed to be an integrated industrial activity with comprehensive shop facilities and engineering, design, and shop skills to accomplish scheduled overhaul and repair of assigned ships.[1] In addition, support often must be provided with little or no advance notice so each shipyard must include a planning wedge in its workload projections for this emergent, usually high-priority work.[2]

Workload-work force balancing has become more difficult in recent years because, as shown in Table 33, there has been a significant increase in the number of direct mandays required to complete ship overhaul and repair work packages.[3] As a result, each overhaul generally uses a major portion of the

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[1]In recent years, naval shipyards have specialized in the support of a total warfare system in lieu of the support of specific ship types. The major benefit of this type of specialization is that ships that operate together are repaired in the same shipyard. (See *Current Status of Shipyards, op. cit.*, p. 193) As a result, shipyards maintain labor, material, and technical expertise to repair and overhaul a wide range of ships and ships systems.

[2]Emergent work can normally be completed during short availabilities. Emergency ship repairs would be a typical example. A reasonable estimate of the effort devoted to emergent work would be 5 to 10 percent of the total production effort in naval shipyards.

[3]Table 33 compares FY-70-72 actual experience with FY-74-75 actual and budget mandays for repairs and alteration. The comparison is not intended to be precise, since the class and number of ships and the condition of the ships overhauled differ between the periods shown. Since "average mandays required" is especially sensitive to these parameters, the v shown can vary considerably over time. For example, the POM-77 pl factors for CVs and LSDs are over 350,000 and 43,000 mandays, respectively. The general trend in all cases is upward.

Table 33. COMPARISON OF TYPICAL SHIPWORK PACKAGES
(Production Shop Mandays)

Ship Type	Repair Package			Alteration Package		
	Average Mandays FY 70-72	Average Mandays FY 74-75	Percent Change	Average Mandays FY 70-72	Average Mandays FY 74-75	Percent Change
CVA	182,143	173,078	-5	113,200	126,836	+12
DE	12,157	25,041	+106	11,036	19,773	+79
DLG	19,207	35,593	+85	12,889	28,306	+120
DDG	23,196	41,778	+80	5,097	28,800	+465
LST	18,879	29,684	+57	2,125	6,030	+184
LSD	33,402	33,315	0	5,317	7,235	+36
AE	17,988	21,670	+20	1,442	9,506	+559
AO	36,358	39,367	+8	2,977	8,399	+182
LPD	33,197	38,426	+16	3,792	9,235	+144
ATF	7,468	8,793	+18	801	2,840	+255

Source: Derived from charts included in NAVSEA Briefing to ASN(I&L), Summer 1974. The text that accompanied the briefing stated that these data illustrate that the growth in depot level work packages is general. The only two exceptions, CVA and LSD, result from the fact that operational constraints caused the work package to be reduced to fit the time available. The sizable increases in alteration packages reflect the Navy decision to emphasize fleet modernization.

total shipyard facilities for a considerable length of time. At the same time, there are sizable variations in manloading by shop as the overhaul progresses. This combination of large, discrete ship work packages and the variations in requirements levied on the different shops over the repair period makes it extremely difficult to program workloads into shipyards on a basis that will optimize manpower curves for each ship and each shop.

Other factors also add to the complicated problem of maintaining a desired workload-work force match. Changes in programmed workloads result from operational and financial constraints applied to the shipyard customers, such as NAVSEA and the fleets. Finally, naval shipyards perform many tasks, including support of tenant activities, not directly associated with the support of assigned ships.

As a result of these factors, it is extremely difficult to workload shipyards in a way to achieve optimum labor utilization. Nevertheless, since labor is an expensive resource and ship repair is a labor-intensive industry, improving the workload-work force match may offer the greatest potential payoff in terms of improving the overall efficiency of shipyards.

Achieving an improved workload-work force match requires the following measures, each of which is discussed below:

- Developing a suitable workload, in terms of level and shop-mix, to permit shipyard management to plan its work force to best accomplish the assigned work.
- Providing shipyard management the flexibility required to adjust its work force if projected workloads are not achieved.

a. Workloads

Currently, the workload options available to the shipyard commander are limited to courses of action that alleviate only short-term work imbalances. For example, all shipyards apparently solicit additional work to maintain a stable workload

during periods when specific activities experience temporary work shortages. Shipwork of short duration that requires work from the shops that are not being utilized fully at a given time are ideal as gap-fillers. Non-shipwork of the right type and of a priority that will not interfere with ship work is also helpful. But there is little the shipyard commander can do to minimize the impact of long-term workload-work force imbalance.

Since the shipyard commander is limited in the extent to which he is able to identify and solicit the right kind of additional work to balance the overall shipyard workload, action by NAVSEA is required. Even at the NAVSEA level, proposed changes are difficult to assess because of the complexity of the shipyard workloading problem. Nevertheless, there are policy changes that could be made that would improve the current workloading of naval shipyards and increase the flow of ships through the shipyard.[1]

The following list identifies several ideas that could be considered in an in-depth analysis of this problem. Each item on the list is offered, without evaluation, to focus attention on areas in which changes would appear to be beneficial.

(1) Reduce the size of the work package for ships assigned to naval shipyards so each ship spends less time in the shipyard. This would permit an increased flow of ships through the yard and a greater opportunity for a more level workload for individual shops. Among the ideas to be considered to reduce the work package are:

(a) Limit the work to be accomplished in the shipyard to those tasks that can be performed only in the shipyard.

(b) Increase the amount of work accomplished by intermediate level and ship's force personnel.

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[1]This would permit the Navy to reduce the "bow wave" of ships requiring depot maintenance. On the other hand, the Navy could decide to reduce the manpower levels authorized for the shipyards because of the increased efficiency of operations.

(2) Limit the time spent in drydock to those tasks that can be performed only in drydock and accomplish more of the repair at pier-side. This would also increase the overall flow of ships through the yard.

(3) Expand the use of a pull-and-replace approach for subsystems and components that require repair during overhaul.[1] This would reduce both the skill level and numbers of technicians needed in each shipyard to perform intricate repair of complex equipment.

(4) Expand the use of shipyards as specialized repair activities to provide work, on a lower priority basis than scheduled shipwork, during short-term lulls in shipwork.

(5) Define and quantify the capabilities and capacities that must be maintained but are not employed full time in each shipyard; this would be the first step in a cost-effectiveness evaluation of the current shipyard utilization concept.[2]

Each of these ideas requires considerable analysis in the context of the Navy's operational commitments. Consequently, any action resulting from efforts to generate a more stable workload in each naval shipyard will probably not provide near-term relief.

b. <u>Improving Flexibility in Adjusting the Work Force</u>

Since the development of a stable workload for each shipyard is unlikely in the near future, granting shipyard

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[1] "Pull and replace" is often used to indicate a maintenance concept in which technicians assigned to a lower echelon replace defective units with units from serviceable stock. Repairable units are shipped to depot-level activities for repair. Increased application of this concept to routine replacement of components that can be removed and replaced through normal access may reduce time required in regular scheduled overhauls.

[2] Efforts to quantify this "standby capability" were unsuccessful. Since one of the first steps needed to control such costs is to define the effort devoted to maintaining a ready-response capability, the Navy should be tasked to undertake such a study. Once the requirement is defined and quantified, either in mandays or dollars, the basis for improving overall efficiency can be estalbished.

commanders the authority to optimize their labor forces to meet actual and projected workloads would provide more rapid relief. This is not an easy task, however, since personnel policy in activities operated under the Industrial Fund concept are subject to the same general rules, constraints, and pressures that affect federal agencies.[1] Thus, the shipyard commander operates under the pressure of the Industrial Fund to employ resources, including labor, in the most efficient manner possible but with only limited authority to adjust his work force to achieve that goal. The authority to assess the local labor market and to select the employment levels, skill mixes, and direct-to-support ratios that best meet actual workloads is essential to successful operation under the Industrial Fund concept.

Among the restrictions that limit the flexibility of the shipyard to adjust its work force are the following:

(1) Limitations on hiring and laying off employees.
(2) Limitations on the use of overtime.
(3) Limitations on the use of temporary employees.
(4) Directed end-year manpower levels.

The impact of these restrictions on shipyard operations should be assessed. Recommendations should be developed to implement those changes that would clearly promote more efficiency in the operation of naval shipyards.

2. Increasing Worker Efficiency

As pointed out early in this chapter, measuring the overall efficiency with which labor is applied in an industrial activity is an extremely difficult task. This is true because the contribution that labor makes to the final product cannot be measured merely by a compilation of the number of direct

[1]Personnel policies in naval shipyards are based not only on the interpretation of congressional, Civil Service Commission, OMB, and OSD decisions but also on manpower and personnel decisions made by the Navy.

manhours expended to accomplish a given task. Such an approach ignores many tangible and intangible factors that affect the number of manhours required to complete assigned tasks. Adjustments can be made for some of the factors when comparing jobs on the basis of the labor required to complete them. Included in this category are differences in the complexity of the tasks involved, in the items included in the total work package, and in the industrial environment[1] in which the jobs are accomplished. Adjustments for other factors, such as differences in worker skill and motivation, supervision, and support, are much more difficult to determine.

Despite the fact that worker efficiency is not easily measured, there are many actions that can be taken to increase efficiency. These actions may be grouped into two general categories:

(1) Efforts to upgrade the quality of the direct work force.

(2) Efforts to improve the support provided to the direct work force.

Included in the first category are efforts to develop improved training programs and to stimulate worker motivation. Included in the second category are efforts to maximize the time spent on the job by each worker by ensuring that he has all of the instructions, equipment, and material required when he is ready to commence work. These efforts focus on improving the overall planning and scheduling process, the quality of supervision, and the effectiveness of other support activities, such as quality assurance and supply.[2] Even though the immediate

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[1]In addition to physical factors, such as weather, this term includes considerations such as the extent to which the task is automated and workers' prior experience in doing the same task.

[2]This approach to improve output by improving the quality of support provided to direct workers embodies highly successful management concepts employed by Admiral Westfall, currently Norfolk Naval Shipyard Commander. Many of his management techniques are being (continued on next page)

impact of most of these actions is an increase in overhead costs,[1] the long-run impact is a reduction in the number of direct mandays required to accomplish specific tasks. As long as the cost of the improved support does not exceed the savings that result from the reduced number of direct mandays required to complete assigned tasks, the overall efficiency of the yard will be improved.

3. Reducing the Cost of Input Resources

Reducing the costs of input resources in an industrial activity is one way to improve overall efficiency. Clearly, any management action that reduces the number of direct labor hours required to complete an overhaul should reduce the direct labor cost for overhaul of the ship. In addition, this action provides the opportunity to improve overall shipyard efficiency either by reducing the size of the work force or by permitting a larger number of overhauls to be completed by the same work force. Similarly, any action that reduces overhead costs, without decreasing the quality of the support provided to the direct work force, also provides an opportunity for an overall improvement in efficiency. To avoid redundancy, the discussion of costs and efficiency has been combined with the discussion of factors that influence the cost of naval shipwork in Chapter V.

D. MONITORING THE EFFECTIVENESS OF NAVAL SHIPYARDS

The discussion so far in this chapter has related primarily to the evaluation of naval shipyard performance in terms of efficiency. This section addresses the problem of evaluating the effectiveness of naval shipyard operations-- i.e., how well

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(cont'd) adopted throughout the Navy as a result of seminars conducted by the Admiral at the request of NAVSEA and OPNAV.

[1] Chapter V discusses overhead costs.

each shipyard performs in accomplishing the workloads that are currently assigned.[1]

As described in the introduction to this chapter, effectiveness measurement compares performance with end objectives to determine how well an activity is accomplishing its goals. Since one of the major objectives of all naval shipyards is to accomplish high quality work on schedule, and at the negotiated cost, effectiveness evaluations must consider the extent to which these objectives were achieved. Thus, whether assigned work was "completed on time and at a reasonable cost" becomes a primary effectiveness indicator, assuming high quality standards are achieved. Commanders and staff members at each of the five naval shipyards visited during this study described this approach as the best way to evaluate overall effectiveness of the shipyard, and the study team concurs in the position that this approach is reasonable.

Despite the fact that this approach to evaluating the overall effectiveness of naval shipyards appears to be reasonable, it is based on certain assumptions that must be considered before this single, overall effectiveness measure can be adopted. First, the basic concept assumes that quality performance is not a significant variable among shipyards. To ensure that this assumption is and remains valid, existing procedures must be modified to assure that data about the quality of the work accomplished become an integral part of the effectiveness measure.[2] For example, all failures that occur within a stated time interval after the ship leaves the shipyard

[1]The much broader problem of current versus wartime capability is discussed elsewhere in this study as an area for further study. See, for example, Section C.1.a earlier in this chapter and Chapter VII.

[2]In addition to extensive inspection during overhaul and a thorough post-overhaul shakedown, data on performance after the ship leaves the shipyard must be evaluated. Such systems as the Casualty Report (CASREP) and the semi-annual fleet evaluation reports on the performance of the shipyards already provide a basis for acquiring these.

could be incorporated into the effectiveness measure to provide insight into the quality of the work accomplished.

A second assumption is that in the process of negotiating with each customer, reasonable estimates are derived that represent a valid basis against which to measure overall effectiveness. This assumption may be questionable but, because of the lack of approved standards, it may be acceptable as an initial basis for comparison. Increased emphasis must be given to the standards program, however, to develop external estimates against which to evaluate the shipyard estimate. Without such standards, the use of the shipyard estimate as a basis for comparing performance among shipyards would be equivocal.

The final assumption to be considered is that a single comparison, at the time the ship leaves the shipyard, is sufficient to evaluate whether "on-time" performance was achieved. Additional milestones in the overhaul cycle should be added to provide a more comprehensive measure. Changes in manday, cost, and schedule estimates must be evaluated against changes in work packages at major points. For example, estimates made at the work definition conference (approximately 165 days prior to the ship's arrival in the yard), at arrival, and at the midpoint of the availability would have to be published with the final estimate to provide a complete effectiveness measure.

Adopting this approach would require increased emphasis on the planning and estimating functions and the development and publication of planning factors and standards of all types. The Navy would not be required to generate new information but merely to raise to a higher level some of the information currently used. This approach places the burden of performance on the shipyard, where it rightfully belongs. The initiative to increase overall performance must be taken at the shipyard. In addition, as the naval shipyards improve their performance, increased pressure would be placed on private shipyards to

become more efficient. Thus, without measuring or monitoring the internal performance of private shipyards, it is possible that improved performance by the private yards would also be achieved.

E. SUMMARY

Generally accepted overall performance measures for naval shipyards do not currently exist because of the difficulty of obtaining directly quantifiable composite measures of output and input. It is possible, however, to compute performance indicators that provide a means of monitoring the efficiency and effectiveness of individual shipyards without measuring performance in absolute terms. Identification of significant shifts in these performance indicators could serve to focus management attention on areas requiring more detailed analysis.

Cost-per-direct-manday-expended ratios and labor ratios are two categories of performance indicators that provide a basis for monitoring the efficiency of shipyard operations. These ratios, easily derived from data routinely reported by naval shipyards, are useful primarily to local managers, since extensive follow-on analysis, at a low level of detail, would be required to interpret shifts that might occur in specific ratios. For this reason, considerable caution must be exercised in using these ratios to evaluate the relative efficiency of naval shipyards. Differences in overhead ratios (cost or labor), for example, may be indicative merely of differences in management approach rather than real differences in efficiency.

Many actions are available to shipyard management at all echelons to improve the overall efficiency of shipyard operations without measuring performance in absolute terms. These actions may be grouped into three general categories. Those that--

(1) Improve the workload-work force match so the mix and level of assigned work match the capability and capacity of each shipyard.

(2) Increase the contribution made by individual workers through improved training, supervision, and motivation.

(3) Reduce the total cost of input resources.

Since a fundamental objective of naval shipyards is to produce quality work, on time, and at the negotiated cost, the effectiveness of naval shipyards can be usefully evaluated in these terms. We believe the Navy should adopt a formal system to facilitate comparing actual performance against goals and standards established for specific categories of work within naval shipyards.

It is possible to evaluate and identify opportunities for improving the overall performance of naval shipyards based on the wealth of detailed cost and manhour data routinely available. Unfortunately, much less detailed data are available to DoD about the performance of private shipyards. As a result, it is difficult to evaluate the efficiency and effectiveness of private shipyards in accomplishing Navy workloads, except in terms of total contract performance. Considerable improvement must be made in the amount of detailed data available about private shipyards if the Navy is to evaluate effectively the potential of the private sector to accomplish projected naval workloads.

This chapter has discussed some of the performance indicators that can be developed from existing data systems. The study team has not attempted to evaluate the relative importance of the indicators because each is important depending on circumstances at the time the trend is identified. For this reason, we recommend that all of these indicators be routinely monitored by local shipyard management. Trends or shifts should be interpreted, based on the experience and judgment of the manager, in the context of the overall operation. Those

changes that are contrary to expectations should be investigated in greater detail to identify management actions that will improve the overall operation of the shipyard.

Although they are generally oriented toward local shipyard management, some of the performance indicators could be used by managers at higher echelons to monitor shipyard performance. For this use, it may be desirable to aggregate the data at a higher level of detail.

Chapter V

FACTORS THAT INFLUENCE THE COST OF ACCOMPLISHING NAVY SHIPYARD WORKLOADS

The preceding chapter stressed the role of costs as an indicator of overall shipyard performance. This chapter addresses costs from two different points of view.[1] First, the major factors that influence the total cost of performing shipyard depot maintenance workloads are discussed. Second, overhead costs and rates are examined separately to define their role as indicators of shipyard performance.

A. INTRODUCTION AND BACKGROUND

1. Industry Trends, FY-70 Through FY-74

As reported by the Department of Commerce, the private shipbuilding and repair industry in the United States has experienced a steady growth over the past several years and is expected to continue growing in the immediate future.[2] Since 1970, there has been an average annual increase of 12 percent in the value of work performed by this industry, and an average 3 percent increase in employment. Over this same period, the value of military work has also increased but at a slower rate such that the portion of total work made up of military work decreased from 56 percent to 46 percent. These trends are summarized in Table 34.[3] A strong market for commercial

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[1]This chapter assumes a general knowledge of the operation of naval shipyards under the NIF. Those readers who desire more information should review Appendix N before reading this chapter.

[2]U.S. Department of Commerce, *U.S. Industrial Outlook--1975*, Chapter 14, "Shipbuilding and Repair," Washington, D.C., 1975.

[3]All dollar values in Table 34 are in current year dollars, as presented in the source documents, and are based on value of (continued on next page)

Table 34. SHIPBUILDING AND REPAIR INDUSTRY: TRENDS 1970-74

(In millions of current dollars, except as noted)

Item	Calendar Years				
	1970	1971	1972	1973[1]	1974[1]
Industry:[2]					
Value of work done	2,682	2,762	3,279	3,780	4,240
Total employment (000)	133.4	128.4	144.6	148.0	150.0
Production workers (000)	108.5	104.7	118.0	122.0	125.0
Product:[3]					
Value of work done	2,594	2,661	3,188	3,500	4,040
Non-propelled new ships	173	234	362	350	370
Self-propelled new military	1,086	1,047	1,092	1,250	1,400
Self-propelled new non-military	514	578	816	1,000	1,300
Repair of military ships	359	325	384	400	440
Repair of non-military ships	431	450	482	470	500
Shipbuilding and repair, n.s.k.[4]	30	28	53	30	30

[1]Estimated by Maritime Administration and Shipbuilders Council of America for 415 establishments. Twenty-five of the 415 establishments account for approximately 60 percent of the work force.

[2]Value of all products and services sold by the shipbuilding and repair industry (SIC 3731).

[3]Value of work done on ships only.

[4]Not specified by kind.

Note: Totals may not add due to rounding.

Source: U.S. Department of Commerce, *U.S. Industrial Outlook--1975: With Projections to 1980*, Washington, D.C., 1975.

energy-related vessels, the passage of the Merchant Marine Act of 1970, and Navy Ship Construction Programs are identified as basic reasons for this growth.

Over this same period, U.S. naval shipyards have experienced a decline in total employment and in costs incurred in accomplishing assigned workloads. At the end of FY-74, total employment was approximately 75 percent of the FY-70 level.

(cont'd) shipments. Adjustment, on an aggregated basis, to reflect constant 1974 dollars reduces the growth over the period to approximately 5 percent. The drop in the value of military work increases from 10 to over 15 percent.

Despite inflation, FY-74 costs were at about 95 percent of the FY-70 level (about 70 percent in terms of 1974 dollars).[1] New construction is no longer assigned to naval shipyards, and the number of naval shipyards has been reduced from ten to eight.[2]

The growth of non-Navy business in private shipyards and the reduction in overall capacity in naval shipyards represent a new environment in which Navy workloads must be accomplished. In prior years, the Navy was the predominant customer for ship new construction. Today, with the growth of federally subsidized programs, construction of commercial ships provides private shipyards a significant alternative.[3] Thus, the Navy must now evaluate its projected new construction program in this new business environment.

Similarly, the environment in which the Navy accomplishes its ship conversion, alteration, and repair work (depot maintenance) has changed. Current Navy policy requires that the total ship depot level workload (including conversions) be split among naval and private shipyards in approximately a 70:30 ratio, based on total dollar value.[4] As shown by Table

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[1]See Chapter IV, Sections B.2 and B.3, respectively, for employment and cost data.

[2]The last ship built in a naval shipyard was completed in FY-72. Puget Sound, Philadelphia, and Mare Island still have the requirement for new construction in their mission statements. As of now, none is planned. Portsmouth has the capability to construct submarines but the requirement is not currently in its mission statement.

[3]Several private shipyard operators testified at the 1974 House Seapower Subcommittee hearings that they would, in fact, prefer business from the private sector. See, for example, U.S. Congress, Committee on Armed Services, *Current Status of Shipyards, 1974,* 93rd Cong., 2nd sess., July-October 1974, Part II, p. 819.

[4]This policy is derived from the guidance of DoD Directive 4151.1, which requires that each Military Department plan to accomplish no more than 70 percent of its gross minimum-essential depot maintenance workloads in government facilities. The Navy has applied this guidance to its total ship maintenance and modernization program. (See, for example, POM-77, Annex D, p.16.) In addition, since FY-74, when Congress required that FY-74 funds amounting to 30 percent of the total repair and (continued on next page)

35, in recent years the Navy has been able to meet this objective. Note, however, that since FY-71, ship conversions, with their large, expensive work packages, have accounted for a decreasing percentage of the total workload accomplished in private shipyards. Concurrently, the alteration and repair workload placed in the private sector has been increased to maintain the 70-30 split of total dollar value. If these trends persist, it may become more difficult to attain the 70-30 objective since a larger number of ships (each with less expensive work packages) would have to be repaired and overhauled in private shipyards. To the extent this occurs, problems could be encountered in two areas. First, the private shipyards must be willing, either by expanding their facilities or by reducing their commercial work, to accept a larger naval repair workload.[1] Second, currently projected workload-work force levels in naval shipyards must be evaluated to insure that inefficiencies are not introduced as a larger share of the repair workload is assigned to private shipyards. Both of these areas of concern are indicative of the wide-ranging impact of the shifting environment in the shipbuilding and repair industry.

2. Comparing the Costs of Accomplishing Navy Workloads in Private and Naval Shipyards

As discussed in Chapter IV, generally accepted output measures for the ship overhaul and repair industry do not exist. As a result it is difficult to compare the relative output of shipyards, except in terms of the total cost of the work

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(cont'd) overhaul program be spent in private shipyards, the Navy has apparently elected to attempt to apply this guideline to the FY-75 and subsequent programs. There is, however, no requirement to assign a specific percentage of this work to private shipyards.

[1]For example, it may be necessary for the private ship repair industry to make substantial additional investments in drydocks, utilities support, and industrial plant equipment.

Table 35. NAVY SHIPWORK FUNDING--ALLOCATION BETWEEN NAVAL AND PRIVATE SHIPYARDS FY 1970-FY 1974

($000 Omitted)

WORK CATEGORY	FY-70	FY-71	FY-72	FY-73	FY-74
ALTERATIONS & REPAIRS[1]					
Naval	593,331	686,583	760,150	836,630	953,793
Private	214,358	135,118	176,832	271,184	422,667
Total	807,689	821,701	936,982	1,107,814	1,376,460
% Private	26.5	16.4	18.9	24.5	30.7
CONVERSION[2]					
Naval	188,200	182,800	266,800	227,500	201,200
Private	149,100	403,200	258,500	335,100	175,600
Total	337,300	586,000	485,300	562,600	376,800
% Private	44.2	68.8	53.3	59.6	46.6
TOTAL CONVERSION, ALTERATIONS & REPAIRS					
Naval	781,531	869,383	986,950	1,064,130	1,154,993
Private	363,458	538,318	435,332	606,284	598,267
Total	1,144,989	1,407,701	1,422,282	1,670,414	1,753,260
% Private	31.7	38.2	30.6	36.3	34.1

[1]Does not include MSC repairs. Includes RDT&E funded shipwork.

[2]Program value.

Source: NAVSEA Letter, *NAVSEA Point Paper Updates*, (0712:AGP), Serial 402, 23 April 1975.

performed. As straightforward as this approach appears to be, such cost comparisons are not only difficult to make in a meaningful manner but can be misleading unless properly presented and interpreted.

Cost comparisons among naval shipyards are facilitated by the fact that workloads assigned to these yards are accomplished under the Navy Industrial Fund system.[1] The Navy has prescribed detailed procedures for NIF operation, including provision for a standard job order cost accounting system. As a result, the total costs of work accomplished in naval shipyards are collected in a systematic way and published in considerable detail. Moreover, since the cost elements reported are identical, it is impossible to make cost comparisons both on a total cost basis and at lower levels of detail.[2]

Cost comparisons among private shipyards are difficult, except on the basis of total contract costs, because of the lack of standard cost accounting systems among firms and because detailed cost information is not routinely reported to the government. Private shipyards accomplish Navy work under the umbrella of the *Armed Services Procurement Regulation*, which prescribes contracting procedures and cost principles.[3] These shipyards, however, are not bound by a set of rigid rules for cost accounting as are naval shipyards. Consequently, there is a lack of uniformity in treating costs throughout the industry.

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[1]As discussed in Chapter IV, costs are not output measures. Both total costs and cost per manday expended are input measures that provide a common basis for identifying changes in output. Hence, both may be used as surrogate output measures.

[2]The Navy has achieved standardization in cost accounting among naval shipyards to a considerable extent. Variations do exist but generally at a low level of detail and do not invalidate most cost comparisons.

[3]*Armed Services Procurement Regulation (ASPR)*, Section XV, "Contract Cost Principles and Procedures."

Most of the Navy ship repair work assigned to private shipyards is accomplished under advertised, fixed-price job orders issued under the MSRC (see Chapter III), for which contractors are not required to disclose details of the cost of performance. Thus, very little detailed data exist for this work. Even for negotiated contracts, it is difficult to obtain detailed information because of the concern of both the private shipyards and government agencies to protect the proprietary nature of the data. The combination of these factors makes it virtually impossible to make cost comparisons on a cost-element basis among private shipyards. The only possible way to make comparisons is on the basis of total costs.

Cost comparisons among private and naval shipyards involve not only the difficulties addressed above, but additional problems as well. On a total basis, detailed review and analysis are required to put the total costs in the two sectors on a comparable basis. For example, naval shipyards do not charge customers for the cost of military personnel, while private shipyards charge for all shipyard labor. On the other hand, private shipyards receive many services from the Navy for which they do not pay (e.g., SUPSHIP support), while naval shipyards charge their customers for similar services. At a lower level of detail, the problem of comparing costs is even more difficult and can be deceptive. For example, despite the fact that the general definitions of direct and overhead costs are the same, there are many differences in the treatment of various cost elements. Even when the titles of cost elements are similar, the actual charges included must be examined closely to ensure that similar charges are made.

Because of the lack of the data required to perform detailed cost comparisons of private shipyard costs, this chapter focuses on naval shipyard costs. Whenever possible, the limited data available on private shipyards are used to illustrate specific points (e.g., the overhead discussion in Section D.3.b).

B. APPROACH AND BASIC DATA SOURCES

A wealth of data is available on naval shipyard performance in the regular NIF reporting system. It was possible, therefore, to conduct detailed analyses of these data to identify significant relationships and trends among cost elements. Special procedures were developed in an attempt to secure relevant data on costs and factors that influence overhead costs in the private sector.

The primary data source on the cost and performance of workloads in naval shipyards was the *Financial and Operating (F&O) Statements* prepared quarterly by the comptroller at each naval shipyard. These documents are products of the standardized cost accounting system used in naval shipyards and provide, among other information, a financial picture of the costs incurred by each naval shipyard in accomplishing its workloads. The statments as of 30 June 1970 through 1974 were used to provide actual cost and manhour data by fiscal year. The data from the *F&O Statements* were supplemented by discussions with NAVSEA and shipyard personnel. The Statistics on Naval Shipyards published by NAVSEA[1] proved to be an extremely useful source for augmenting the data contained in the narrative portion of the *F&O Statements*. The data extracted from these sources were supplemented by visits to five naval shipyards.

Three approaches were used in an effort to obtain cost data about private shipyards:

(1) Questionnaires were sent directly to ninety-five private shipyards.

(2) A Data Request was submitted, through NAVSEA, to all SUPSHIP offices.

(3) The Cost Accounting Standards Board was asked to provide Disclosure Statements for all shipyards.

[1] *Statistics of Naval Shipyards (SONS)*, published quarterly by the Industrial Activity Performance Evaluation Division, NAVSEA (072).

Only partial success was achieved in securing data on private shipyards. The data that were obtained are incorporated in the following sections of this chapter. In addition, a summary of the responses is presented in Appendix P.

C. FACTORS THAT IMPACT ON TOTAL COSTS

Total cost is a basic consideration in planning and accomplishing Navy depot maintenance workloads. Overhead costs are important, but as pointed out earlier, must be evaluated in the context of total costs when performing comparative analyses, since specific cost elements may be handled in many different ways. For this reason, the discussion in this section emphasizes the overall cost impact of selected "driving" factors or independent variables that most significantly influence total costs.

1. Mission

Differences in the basic missions of naval and private shipyards help explain a significant part of the difference in the cost of accomplishing similar work in the two types of yards. The mission of naval shipyards covers a wide area and is a major factor in the cost of accomplishing assigned workloads. Naval shipyards are required to maintain the capability to respond to a broad range of fleet support requirements. Under certain conditions, support must be provided with little or no advance notice because a significant part of a naval shipyard's workload is emergent (unscheduled) work.[1] The naval shipyard does not even control its scheduled workload, although it is able to influence decisions on it to a limited extent. Changes in total programmed workloads for scheduled work that result

[1]A reasonable estimate of the effort devoted to emergent work would be 5 to 10 percent of the total production effort.

from financial and operational constraints encountered by NAVSEA and the fleet and type commanders must be absorbed by the yards. Labor, material, and technical expertise must be available to support a wide range of ship systems and subsystems. In addition, naval shipyards perform many tasks and support tenant activities not directly associated with the support of ships assigned to the yard. These kinds of activities, even if carefully managed, detract from the basic purpose of the shipyard.

The combined effect of all these factors is that many resources (both labor and material) must be maintained that may not be employed on a full-time basis.[1] Only limited alternatives are available to the shipyard commander to compensate for the impact of most of these factors. As a result, whenever actual workloads do not match capacity, overhead costs will tend to increase. Thus, the basic role of naval shipyards forces these yards to incur higher overhead costs than would be necessary in a private shipyard.

Managers of private shipyards, subject to the constraints of a competitive industry, have considerably more flexibility in shipyard operations than do naval shipyard commanders.[2] For example, based on assessments of the market, decisions are made about the size of the yard, employment levels, and the type and timing of the workload to be pursued. Thus, shipyard capability and capacity can be tailored to accomplish projected workloads. In addition, private yards are able to adjust more quickly to

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[1]As pointed out in the preceding chapter, efforts to quantify this "standby capability" were unsuccessful. Since accurate identification of these costs is essential to effective decision making, efforts to identify standby requirements and cost are essential.

[2]The pressure of competition must be considered a mixed blessing. Private shipyards are generally able to select from the work offered, while naval shipyards generally are assigned work. Naval shipyards, however, have the advantage of planning that attempts to provide stable workloads. Private yards, generally, do not enjoy this advantage.

a changing business environment and thereby better control their costs. These factors, as well as many others, are well known. Many of these basic differences cannot be controlled by the Navy. Nevertheless, they must be recognized and evaluated in comparing the relative cost effectiveness of shipyards in accomplishing Navy workloads.

2. Workload-Work Force Balance

This section discusses the problem of matching available labor to assigned work in the day-to-day operation of shipyards. This matching is a short-run problem as opposed to the problem of optimizing the capability and capacity of shipyards to accomplish projected workloads over a future time period consistent with Navy long-range plans.

Private and naval shipyards have different options open to them to match available labor to actual work. Hence, the impact on costs is different, and once again, the private shipyard, because of the flexibility it has in rapidly adjusting its work force, has an advantage over the naval shipyard. Consider, for example, a situation in which a short-range problem arises that reduces scheduled workload by 50 percent for a period of two months. Private shipyard management could normally initiate layoffs--some with as little as three hours notice and all with only verbal promise of recall. Naval shipyard management, on the other hand, could drop temporary employees from the payroll relatively quickly but would be unable to layoff permanent employees to accommodate such a short-term situation. Thus, the naval shipyard would have to pay for labor for which alternative workloads might not exist.

Work scheduling in repair activities is a complicated function. A major consideration is, of course, the number of ships assigned to the yard for repair. In recent years, ship overhaul and repair requirements have increased in terms of the length of time and number of mandays required to complete a

specific work package.[1] As a result, each overhaul assigned to a shipyard uses a major portion of the facilities and work force for a considerable length of time. At the same time, manpower requirements, by shop, for repair activities vary considerably over time. The shape and maximum level of manpower distribution curves differ according to the type of ship and the work package to be accomplished. Thus, labor-force scheduling is a problem of matching manpower distribution curves, by shop, with large, discrete shipwork packages. It is extremely difficult to optimize manpower distribution throughout the year for each shop in the shipyard and for all ships undergoing repair in that year. Irregular workloading--peaks and valleys--therefore occurs at both the shipyard and the shop level, and it has a significant effect on costs.

The problem of peaks and valleys in workload is one element in matching the work force to the actual workload. Another element is employment level. Under Civil Service and DoD procedures, each naval shipyard is required to submit a manpower plan to support its annual budget.[2] This plan is the result of an iterative process in which NAVSEA attempts to match projected shipwork requirements to available resources. The actual shipyard employment levels that result from this effort reflect both the capability the Navy wants to have at each shipyard and the yard's share of the total projected workload. To the extent the Navy is able to adhere to its work schedule, these employment levels reflect a suboptimization of total Navy resources to accomplish planned ship workloads.

In effect, the employment levels imposed on the shipyard define the total cost of labor in the shipyard for that year. With the long lead times required to adjust employment levels

[1]See Chapter IV, Table 33.

[2]The manpower plan includes total civilian employment levels throughout the year as planned by the Navy to accomplish required workloads and to meet end-year budgetary control manpower ceilings.

under current Civil Service regulations, the shipyard commander has very little flexibility to deviate from the manpower plan.[1] Thus, changes in planned workloads generally have an unfavorable cost impact. This impact is manifested, generally in one of two ways:

(1) Failure to generate the workload on which the employment levels were based is reflected not as a change in the total labor cost of the shipyard but as a shift between direct and overhead charges.[2]

(2) Work in excess of planned levels may be reflected as an increase in either overhead or direct labor costs.

If overtime is used to meet temporarily heavy workloads, the increased cost is either a direct or overhead charge depending upon whether the customer is under the umbrella of a fixed-price contract or approves the overtime cost.[3] For excess workloads of greater duration, other alternatives, such as revising schedules or securing authorization to hire additional temporary employees, would most likely be pursued. In any event, the increased cost of shipwork is passed ultimately to the customer either directly or through increased applied overhead rates. The latter means a higher cost to all shipyard customers.

Private yards, as noted above, have much greater flexibility in adjusting the work force to actual work. Thus, the private shipyard is able to control total labor costs to a greater degree than the naval shipyard. A major advantage in

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[1]Meeting end-year levels is an obvious constraint. The total impact is felt throughout the year, however, since all funding is based ultimately on these employment levels. Major deviations impact on not only the individual shipyard but also the customers who must reimburse the shipyard for work performed.

[2]This is true to the extent that other work cannot be found to fill the gap. Short ship availabilities, for example, are ideal for this purpose since the repair operation would most likely provide additional work for many different shops.

[3]See Appendix N.

the private shipyard is the unrestricted use of temporary employees.[1] Naval shipyards are limited in this respect by the manpower plan.

In summary, ship depot maintenance is a labor-intensive activity in which manloading is dependent to a large degree on the specific requirements of each shipwork package. In addition, the duration and manday requirements of most availabilities have grown in recent years to the extent that a relatively small number of ships can tie up a major part of a shipyard's capability for a considerable time. The combined effect of these two factors is that it is difficult to match work force with actual workloads. Private shipyards have much greater flexibility in adjusting their work force than do naval shipyards. As a result, naval shipyards are forced to incur higher costs than private shipyards.

3. Wage Rates

The discussion in this section assumes a general knowledge of the Federal Wage System. Emphasis is focused, therefore, on the impact of specific provisions of the system on naval shipyard costs.[2]

As stated earlier, labor costs account for approximately 75 percent of the total costs incurred by naval shipyards in accomplishing assigned workloads. Because the basis for labor costs is the hourly wages paid to employees, the level and rates of change of these wages have a large impact on the cost of work accomplished.

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[1]Subject to the available supply of labor. In discussions with personnel from private yards, it was established that many yards maintain a cadre of skilled personnel (those with skills not readily available in the labor market) and resort to hiring halls to handle fluctuations in workload.

[2]Appendix O of this paper presents a description and evaluation of the Federal Wage System. Readers who desire a detailed explanation of the overall operation of the system should review Appendix O before reading this section.

Wages for the wage employees in naval shipyards are of special interest for two reasons:

(1) Wage employees account for over 75 percent of the total naval shipyard work force, including the skilled mechanics who provide the basic "hands-on" capability of the shipyards.

(2) It is generally accepted that wages for wage employees are significantly higher than wages for employees in comparable jobs in private shipyards.

Figure 39 summarizes two recent milestone studies of shipyard costs.[1] Higher wages and fringe benefits were cited in both studies as a major cause of the higher costs of work accomplished in naval shipyards. The 1972 Booz-Allen study, based on analysis of average basic wages per manhour in naval shipyards and Bureau of Labor Statistics data for wages in private shipyards, estimated the wage differential to be about 17 percent as of the end of calender year 1971.[2] In testimony during the 1974 Seapower hearings, the Navy stated the wage differential was about 15 percent.[3]

Wage employees are paid in accordance with rates established under the procedures of the Federal Wage System. This system was established by Congress to assure that wages received for jobs in federal agencies were comparable to wages for equivalent jobs in private industry within the same local area. Federal agencies and local employers would thereby compete on an equal basis for the available supply of labor. As currently implemented, however, the system operates to assure that wage employees in naval shipyards receive higher hourly wages than

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[1]See Ernst and Ernst, *Survey of Cost Differentials and Other Factors--Private Versus Naval Shipyards*, Shipbuilders Council of America, Washington, D.C., 1971; and Booz-Allen Applied Research, Inc., *Study of the Relative Costs of Ship Construction, Conversion, Alteration, and Repair in Naval and Private Shipyards*, Washington, D.C., 1972.

[2]Booz-Allen, *op. cit.*, p. II-52.

[3]*Current Status of Shipyards, op. cit.*, Part I, p. 185 ff.

<table>
<tr><th>Ernst & Ernst, 1971
(Time Frame--1970)</th><th>Booz-Allen, 1972
(Time Frame--1966-1971)</th></tr>
<tr><td colspan="2">Methodology</td></tr>
<tr><td colspan="2">Data collection

Both used naval shipyard (NIF) financial statements (100 percent sample). Both used private shipyard financial data, assembled by questionnaire, interviews or both. Details of samples varied widely and individual details to follow:</td></tr>
<tr><td>Private yard inquiries covered 200 companies with 21 companies responding. Responding sample covered 24 percent of gross private yard sales. No New Construction or Repair and Alteration breakout attempted.

For ship cost data on Conversions, 3 each DLG's private and naval (Bath and Philadelphia) were obtained.</td><td>Fifteen private yards, (with 11 fully participating) were involved. Finally selected sample covered (as percent of total sales Government and Private) was:

New Construction - 39 percent
Conversion - 35 percent
Repairs and Alterations - 9.5 percent</td></tr>
<tr><td colspan="2">Analysis

Using different techniques, both adjusted financial data to take into account discrepancies between content of Government and Private financial returns (capitalization, interest costs, taxes, insurance rental expense, etc.). Booz-Allen had access to specific ship data and, starting with 100 percent sample, eliminated from the full sample ships or work considered not comparable between naval and private shipyards. Comparative analyses were then made. Booz-Allen included Government Furnished Material (GFM) in its new construction analyses. Ernst and Ernst essentially included GFM.</td></tr>
<tr><td colspan="2">Conclusions</td></tr>
<tr><td>Cost of production worker hour in naval shipyards is 49 percent higher than in private yards. (Range was 44-79 percent.)

Man-hours expended on similar jobs in naval shipyards is 39-59 percent higher than in private yards.

Cumulative effect of foregoing is that naval shipyard costs could be 109-124 percent higher than in private yards.</td><td>Higher costs in Government for work done in naval shipyards than that done in private yards. Differentials range from approximately 20-100 percent. Highest differential in conversions (17-115 percent); New Construction differential is 40 percent; repair differential is 23 percent. (GFM is weighted into new construction costs).</td></tr>
<tr><td colspan="2">Causative Factors of Differentials</td></tr>
<tr><td>Higher overhead costs account for most of the production worker man-hour cost differential. Higher average wage rates and more liberal fringe benefits account for remainder.</td><td>Significantly higher levels of pay and fringe benefits---blue collar 17 percent, white collar 10-40 percent---and higher overhead rates.

Maintenance of a full range of capabilities.

Lower productivity.

Disruptions from responding to emergent fleet demands.</td></tr>
</table>

Source: Testimony of Shipbuilders Council of America, *Current Status of Shipyards--1974*, Hearings Before the Seapower Subcommittee of the House Armed Services Committee, July-October 1974, p. 646.

Figure 39. COMPARATIVE CONTENT OF TWO MAJOR STUDIES OF NAVAL SHIPYARD COSTS

their counterparts in local private industry. This section discusses several provisions of the Federal Wage System that cause this situation.

a. Using the Average Wage in Private Industry to Establish the Wage for the Second Step of Each Federal Wage Grade

The Federal Wage System requires that wage rates for federal wage employees be based on the average wage rates for workers in comparable jobs in local private industry. During annual surveys, data are collected about the number and hourly wage rates of employees in jobs in local industry that are determined during the survey to be comparable to jobs performed at the various wage-grade levels in the Federal Wage System. The data for each area are used to develop a prevailing wage rate trend line which is used to establish a new baseline rate for each grade in the federal wage rate structure. Thus, the baseline rate in each grade is adjusted annually to reflect changes in wages in local private industry.

The Federal Wage System establishes five in-grade pay levels for each wage grade. Each pay level, designated as a "step," is 4 percent higher than the preceding level. For each grade, the wage rate for step two is established at the baseline level determined from the annual survey data. Since federal wage workers progress to step two after only six months in a wage grade, all but a small percentage of federal wage workers receive wages at least equal to the baseline rate. Moreover, after a total of two, four, and six years in a wage grade, all federal wage employees progress automatically to steps three, four, and five, respectively, and receive wages that are 4, 8, or 12 percent higher than the baseline rate. This provision of the Federal Wage System is the major reason why wages for federal wage employees are significantly higher than wages for workers in comparable jobs in local private industry.

During the period FY-70 through FY-74, over 75 percent of naval shipyard wage employees were at step three or higher. The majority automatically moved to step four in April 1973 when step four was first implemented. In April 1975, when these employees completed the prerequisite two years at step four, they moved automatically to step five.[1] Therefore, when naval shipyard worker wages are adjusted as a result of a particular annual wage survey, the majority of these workers receive wages 12 percent above the level received by their counterparts in local private industry. (As will be discussed below, wages in private shipyards are generally lower than wages for most of the jobs included in the survey data base. This causes naval shipyard wages to be even higher than the 4 to 12 percent differential caused by the provision described above.)

b. <u>The Multi-Industry Data Base</u>

Wage rates in naval shipyards are based on data collected from private establishments in many industries. This multi-industry approach is intended to ensure that the data collected reflect average wage rates for all jobs in private industry that are comparable to jobs filled by government employees covered by the Federal Wage System. Thus, the wage rate schedules derived from these data will be applicable to all federal jobs in the local area rather than merely those assigned to a single agency.

Regardless of the merits of this multi-industry approach, its use is one of the reasons that wages for jobs in naval shipyards are higher than wages for comparable jobs in private shipyards. As indicated in Table O-3 in Appendix O, average hourly earnings for private shipyard workers are lower than hourly wages for many of the jobs included in the wage surveys. Thus, average wage rates derived from data collected during the

[1] *Current Status of Shipyards, op. cit.*, p. 130.

survey would be expected to be higher than average wages for private shipyard workers. Since wages for workers in naval shipyards are based on this higher multi-industry wage level, current procedures provide a built-in mechanism to keep wages in naval shipyards higher than in private shipyards.

The fact that the multi-industry approach, as currently implemented, has an inflationary impact on labor costs in naval shipyards is not in itself an indictment of the overall concept. The use of a multi-industry approach may be justifiable to the extent that the data collected reflect average wage levels for all job skills in all industries with which federal agencies are competing for the available labor supply. Since many job skills can be utilized in more than one industry, a multi-industry approach would appear to be preferable although this is by no means certain.[1] It may be that shipyard operations represent a unique situation and may require special wage rate considerations.[2]

c. The Survey Data Base

The success of the survey approach to determining the prevailing wage rates in each wage area is a function of many factors including the extent to which--

(1) The establishments and jobs included in the survey constitute a valid sample of private industry in that area.

[1]Based on discussions with personnel from both private and naval shipyards, all skills used in shipyards can be used in other industries and vice-versa. Differences of opinion exist, however, as to the amount of additional training and on-the-job experience required when personnel from other industries are hired by the shipyards.

[2]An evaluation of the relative merits of a multi-industry approach versus a single-industry approach is beyond the scope of this paper. Such an evaluation must be included, however, in the overall review of the Federal Wage System that is recommended in Chapter VII and Appendix O. Since the stated objective of the Federal Wage System is to achieve comparability between private and federal wages, providing for intentional wage differentials between private and naval shipyards would probably require action by the Congress.

(2) The data collected from each establishment are accurate and representative of actual wage rates for local private industry.

The first of these factors is primarily the responsibility of the CSC, which, in conjunction with the BLS, designates both the jobs and establishments to be surveyed.[1] The second, however, is highly dependent upon the work of the Lead Agencies and the data collection teams.

This section discusses several factors related to current data handling procedures that justify further analysis. Without a detailed review of actual survey data, however, the extent to which these factors influence survey results cannot be quantified.

Data collection teams consist of two workers (one management and one union representative) assigned to federal activities within the local survey area. The Lead Agency normally provides two weeks training prior to the survey. During the survey, the teams interview local employees to obtain prescribed job, employment, and wage rate data. These data are used to derive the average wage rate for each federal wage grade, as described in the preceding section.

A review of current procedures identified three primary potential problem areas:

(1) Effectiveness and objectivity of the collectors.

(2) Accuracy of the data reported by the private establishments.

(3) Minimum criteria for an adequate data base.

As discussed in Appendix O, several actions--all within the prerogatives of the Lead Agencies--could alleviate many of these potential problem situations.

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[1]The Lead Agency, normally the federal agency with the largest number of employees in the area, does have the opportunity to influence the survey establishment and job lists but, generally, only with approval of the CSC.

Data Collectors. Once trained, the judgment of the collectors in determining that specific jobs in private industry are comparable to federal job descriptions is basic to the wage determination process.[1] Thus, the use of non-professional data collectors, who stand to benefit from the results of the survey, is a potential problem area since the teams have opportunities to raise average rates by failing to consider low-paying jobs that involve comparable duties.[2] The use of full-time professional data collectors assigned, for example, to the BLS would alleviate the problem, but these employees would still be federal employees. The use of non-federal employees could help correct this problem.

Data Accuracy. Participation by industry in the survey is voluntary. The data provided are reviewed by the Lead Agency for consistency with data reported in prior surveys, but no formal audit is performed. Since careless or indifferent reporting by representatives of local establishments can have an important influence on survey results, improved means of verifying reported data must be incorporated into survey procedures.

Criteria for Judging the Adequacy of the Data Collected. Federal wage procedures describe the criteria for determining the adequacy of the data base in terms of the number of jobs and job matches. Under current criteria, it is possible that the entire wage rate schedule could be derived from raw survey

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[1]A job in private industry need not be identical to a federal job to be classified as a "job match" as long as similar duties are performed. Thus, subjective judgments are required.

[2]Wage employees, of course, benefit directly since they are paid in accordance with the wage schedules derived from the survey data. The general-schedule employees, who are normally the management representatives, can hardly be expected to be disinterested. Although their pay is based on nationwide levels, the pay of wage employees does impact on these averages. Thus, the "so-called" management representative also stands to benefit from the survey.

data for as few as 10 jobs and 120 private shipyard employees.[1] While such a situation may provide an accurate picture of the labor market in some wage areas, the legitimacy of these criteria as overall standards should be reviewed in an evaluation of the Federal Wage System.

d. Requirement to Import Data from Outside the Local Wage Area

This provision of the Federal Wage System has received considerable publicity.[2] While it is true that this provision causes wages for some wage grades to be higher than they would otherwise be, its impact is minor compared with other provisions of the Federal Wage System. For example, as shown in Table O-5, Appendix O, in 1974, this provision increased wage rates for grades one and two at only two of the eight naval shipyards. For all other grades, data from within the local area were used to determine final wage rates. Compared with the impact of the "step-two" provision, which causes most wages in all shipyards to be from 4 to 12 percent higher than they would otherwise be, this impact is minimal. Thus, this provision of the Federal Wage System is not a major area of concern.

4. Nuclear Work

While it is reasonable to expect the special facilities and procedures required to perform nuclear work to cause the cost of nuclear repair to be higher than the cost of comparable non-nuclear repair, the magnitude of the differential was not estimated in this study. For naval shipyards, information on nuclear costs is routinely published by job order and in detail by the standard NIF cost centers and cost classes.

[1]See Appendix O, Table O-4.

[2]The requirement to import data was added to the Federal Wage System by the "Monroney Amendment" passed by the Congress in the late 1960s.

These data provide a reasonable basis for identifying at least some of the costs of nuclear versus non-nuclear work based on the way expenses are charged. Unfortunately, however, the detailed job order information required to make specific cost estimates could not be obtained by the IDA study team within the time available to complete this study. This section attempts to provide some insight on the effect of the nuclear mission on the cost of naval shipyard operations based on data routinely available in the *F&O Statements.*[1]

a. Accounting for Nuclear Costs Under NIF Procedures

The NIF job order cost accounting system for shipyards requires that all job orders be coded to distinguish between nuclear and non-nuclear work; therefore, it is possible to retrieve separate data on the costs charged to these two kinds of work.[2] Naval shipyards, for example, publish total cost and manday data for each ship at the end of its availability.[3] These data are summarized by major work category (e.g., nuclear and non-nuclear repair; see Appendix N, Table N-1 for a complete list of work categories). In addition, detailed cost and manday data provided for each job order in the total shipwork package

[1]In addition to the data currently provided by the standard NIF cost and job order accounting system, there may be additional information available at a lower level of detail and on a different basis that could be provided. Modifying the NIF accounting system to provide additional detail on nuclear costs is identified as an area for further study (see Section B.1, Chapter VII).

[2]The Nuclear Power Directorate (NAVSEA 08) prescribes all standards and procedures for nuclear work. Individual shipyards have compiled this information into local "Nuclear Power Manuals" to facilitate shipyard operations (see, for example, Norfolk Naval Shipyard, "Shipyard Nuclear Power Manual," NNSYI 98-90-1, as amended). Specific criteria are established to define nuclear tasks and, as required, the interface between nuclear and non-nuclear portions of related tasks.

[3]See, for example, NAVSHIPS Report 4790-3, "Customer Order Summaries."

permit analysis of the relative costs of nuclear and non-nuclear work at the job order level.[1]

In addition to the nuclear job order system, the NIF cost accounting system establishes several cost centers and class codes that are unique to the nuclear mission (see Figure 40). As a result, cost data, at various levels of detail, can be extracted from the *F&O Statements* to provide some insight into the effect of the nuclear mission on costs. Three of the cost centers are production centers for which total overhead, by cost class, and total direct labor costs are published. Less detail is available for the general cost centers. For those general cost centers that are unique to the nuclear mission, total overhead is available. For others, only those overhead costs that are identified by nuclear-unique cost class codes are available.

b. Costs for Cost Centers Unique to Nuclear Work

Table 36 summarizes the percentage of total costs that can be attributed to the nuclear-unique cost centers and cost classes listed in Figure 40. Percentages are shown for each of the six naval yards that currently perform nuclear work. The first column indicates the relationship of the direct labor expended in the three nuclear-unique production centers to the total direct labor expended by the shipyard. These centers account for less than 10 percent of the total. The second column indicates the relationship of the total production overhead costs for the three nuclear-unique centers to the total production overhead costs incurred by each shipyard. In terms of

[1]Despite the fact that these reports were not obtained during the study, this analysis would be useful to provide a first approximation of the costs of nuclear work. The Navy should be asked to provide at least the summary report on a routine basis. Even though analyses would have to be performed manually, these reports would provide increased visibility into the cost of ship depot maintenance work.

Production Centers	
9908	Quality and Reliability Assurance-Radiological Control
9909	Radiological Control and Nuclear Inspection
9913	Nuclear Power Division
Manufacturing Centers	
9218	Nuclear Type Desk (Planning Department)
9238	Nuclear Job Planning (Planning Department)
9328	Nuclear Production Services (Production Department)
9388	Nuclear Facilities and Equipment (Production Department)
Administrative Centers	
9408	Weight Handling Equipment - Nuclear
9440	Weight Handling Equipment - Nuclear (Maintenance)
9821	Maintenance and Operation of Service Craft Nuclear
Cost Classes	
38	Training - Nuclear
66	Maintenance of Nuclear Equipment
73	Maintenance of RADCON Barges

Source: Extracted from Tables N-2 through N-4, Appendix N.

Figure 40. NAVY INDUSTRIAL FUND COST CENTERS AND COST CLASSES UNIQUE TO THE NUCLEAR MISSION

Table 36. PERCENTAGE OF DIRECT LABOR AND OVERHEAD COST ATTRIBUTABLE TO NUCLEAR-UNIQUE COST CENTERS AND COST CLASSES

	Production Centers		General Centers
Naval Shipyard	Percent of Total Direct Labor Cost	Percent of Total Production Overhead Cost	Percent of Total General Overhead Cost
Charleston	7	16	6
Mare Island	5	12	6
Norfolk	2	6	3
Pearl Harbor	*	15	5
Portsmouth	8	15	6
Puget Sound	10	17	8

*Detail not published in *F&O Statements*.

Source: Operating Summaries, *F&O Statements*, 30 June 1974.

the contribution to actual production overhead costs, these three centers account for 15 percent of the total. Although these data are too general to permit definitive conclusions, the two relationships do show that nuclear-unique centers account for a disproportionate amount of production overhead. Considerably more extensive analysis to compare manhours and costs on a center-by-center basis would be required to achieve improved visibility into the cost of nuclear work. The final relationship shown in Table 36 (column 3) indicates that only a small percentage of total general administrative costs can be attributed explicitly to the nuclear mission. Except at Norfolk, the nuclear-unique cost centers and classes account for approximately the same percentage of each category shown.[1]

Table 36 merely illustrates the amount of information that can be attributed to nuclear-unique cost centers and cost classes in the NIF cost accounting system. The data are too

[1]The lower percentages at Norfolk reflect lower manning levels in these production centers. As Norfolk expands work in the surface nuclear area, manning levels would be expected to increase.

highly aggregated to be of practical value without extensive analysis at a lower level of detail. The only positive conclusion that might be drawn is that very little visibility into details of nuclear versus non-nuclear costs is provided in the current cost accounting system.

c. Comparison of Manhour Costs for Selected Nuclear and Non-Nuclear Cost Centers

Table 37 summarizes the cost per manhour for selected production cost centers at two nuclear and two non-nuclear shipyards.[1] The centers displayed represent a cross section of shipyard activities engaged in nuclear and non-nuclear work. For discussion purposes, the cost centers are divided into three categories--nuclear-unique, complex, and shop--that provide a gross indication of the type of work performed. The term complex is used to indicate that the staff for this center is composed primarily of engineers and other technically oriented employees as opposed to the trade-oriented employees in the shops. For each cost center, the hourly cost of direct labor, applied production overhead rate, and total manhour cost are shown. The primary purpose of the table is to facilitate comparison of hourly rates in various cost centers within individual shipyards to highlight the relative hourly cost of work performed. Comparisons among shipyards are less precise because the data have not been normalized. The comparisons are nevertheless useful to identify significant trends among the shipyards.

Despite considerable variation in the data displayed in Table 37, the table can be used to emphasize several significant relationships. First, based on the average ranking of the three categories displayed, the direct, overhead, and total hourly

[1]Long Beach and Philadelphia are the only two non-nuclear shipyards. It was assumed that one nuclear yard on each coast was sufficient to support this presentation.

Table 37. AVERAGE HOURLY COST OF DIRECT LABOR AND APPLIED PRODUCTION OVERHEAD FOR SELECTED COST CENTERS IN SELECTED NAVAL SHIPYARDS

Cost Center[1]	Naval Shipyards: Mare Island (Nuclear)	Long Beach (Non-Nuclear)	Philadelphia (Non-Nuclear)	Portsmouth (Nuclear)
Nuclear Unique				
9908 Quality Assurance (RADCON)				
Direct Labor	8.04	N/A	N/A	6.72
Applied Overhead	11.90			10.04
	19.94			16.76
9909 Quality Assurance (Nuclear Inspection)				
Direct Labor	9.13	N/A	N/A	7.14
Applied Overhead	3.77			5.99
	12.90			13.13
9913 Nuclear Power Division				
Direct Labor	10.54	N/A	N/A	9.54
Applied Overhead	10.57			7.35
	21.11			16.89
Complex				
9904 Design Division				
Direct Labor	8.80	8.00	8.36	8.08
Applied Overhead	1.52	2.14	2.55	2.72
	10.32	10.14	10.91	10.80
9905 Quality Assurance (Shop)				
Direct Labor	8.90	7.83	8.14	6.15
Applied Overhead	2.84	1.18	4.59	3.98
	11.74	9.01	12.73	10.13
9910 Industrial Laboratory				
Direct Labor	7.95	8.00	8.11	7.61
Applied Overhead	6.47	6.80	4.67	9.44
	14.42	14.80	12.78	17.05
9924 PERA				
Direct Labor	N/A	N/A	9.39	9.24
Applied Overhead			2.10	2.20
			11.49	11.44
9990 Combat Systems Office				
Direct Labor	10.61	8.67	9.26	8.74
Applied Overhead	5.88	3.05	2.55	2.89
	16.49	11.72	11.81	11.63
Shop				
9926 Welding Shop				
Direct Labor	7.76	6.75	6.19	5.58
Applied Overhead	4.69	2.08	2.78	3.15
	12.45	8.83	8.97	8.73
9931 Inside Machine Shop				
Direct Labor	7.28	6.33	6.05	5.45
Applied Overhead	3.01	2.36	2.83	4.14
	10.29	8.69	8.88	9.59

[1]For each cost center, Direct Labor, Applied Production Overhead and Total Cost Per Manhour are shown.

Source: Derived from *F&O Statements*, June 1974.

cost of labor expended in nuclear-unique centers is higher than in the other categories. The cost of labor in the category identified as complex is the second most expensive in nuclear yards and the most expensive in non-nuclear shipyards. In every shipyard, the cost of shop labor is lower than the cost for other categories of labor.

On the basis of individual cost centers, the applied overhead rates for the nuclear-unique centers are generally higher than the rates for other cost centers.[1] Two factors help explain the magnitude of the overhead rates in these centers. First, since these are production centers, total overhead costs are allocated on the basis of direct labor charged to job orders. However, these centers charge a lower percentage of their available labor to job orders than do most production centers so costs are allocated over a smaller base. Second, the work force in nuclear-unique centers comprises primarily engineers and other highly skilled employees, and labor rates for these skills are higher than for most skills in the shipyard.

The costs shown also illustrate the high hourly cost of support workers when compared with the cost of the basic, "water-front" workers. Although the costs incurred in the non-shop cost centers displayed in Table 37 represent a relatively small part of total cost of work performed in naval shipyards, these centers are relatively expensive activities on a manhour basis. The output of these centers, however, is vital to the performance of shipyard workloads. These relationships emphasize the importance of determining the proper balance between shop and support workers.

[1]Note, however, the rate for the Industrial Laboratory also ranks among the higher overhead rates. Since this cost center is also a highly specialized center with work force characteristics similar to the nuclear-unique center, it would appear that this fact may account for the high overhead costs.

d. Impact on Direct Labor Cost in Production Shops

The above discussion emphasized several important aspects of the impact of the nuclear mission on shipyard costs. It did not address, however, what is apparently the major cost impact of nuclear work, namely, the increased amount of time spent on a nuclear job order. Unfortunately, this aspect of nuclear work is difficult to measure without an extensive analysis at the job order level and below. Considerable evidence at a higher level, however, provides insights into why a nuclear job would be expected to incur a higher direct labor charge than would a similar non-nuclear task:

(1) The rigid work procedures and potentially hazardous work environment cause the worker to spend more time planning for the job. In this way, exposure to the nuclear environment is minimized without sacrificing the quality of the work.

(2) The high standard of performance required for nuclear work, together with stringent inspection requirements, creates many stop-start situations that increase the time spent on the job by the worker, quality assurance inspectors, and technical advisers and engineers.

(3) Tasks incidental to performing nuclear work, such as suiting-up, radiological monitoring, and decontamination procedures, increase the time spent on each job order. Under NIF procedures, most of the above factors are direct charges to the job orders.[1]

D. EXAMINATION OF SHIPYARD OVERHEAD COSTS AND RATES[2]

This section addresses the general subject of overhead costs in naval shipyards in terms of actual rates, and discusses problems in using those rates to evaluate and compare shipyard

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[1]One way to improve the evaluation of the impact of the nuclear mission on total costs would be to revise the cost accounting system. Additional cost centers and cost class codes could be added that would identify specific functions associated with nuclear tasks.

[2]See Appendix N, page N-14, for a more detailed discussion of overhead costs and rates.

performance. A brief discussion of overhead in private shipyards, based on data obtained from the Cost Accounting Standards Board, is included to illustrate the extent to which overhead costs are handled differently by various private shipyards. The problem of sensitivity of overhead costs to specific factors and cost elements is not included since accumulation of the extensive data base required to support a comprehensive analysis of this subject was outside the scope of this study. The subject, however, is discussed as an area for further study in Sections B.5 and F, Chapter VII.

1. Actual Overhead Rates for Naval Shipyards

Naval shipyards use predetermined (applied) overhead rates throughout the year as the basis for billing customers. As actual costs are accumulated, overhead rates are computed to provide cost center managers a means of comparing actual to planned (budgeted) costs.

Table 38 displays actual overhead rates for each of the three major overhead categories used by naval shipyards. Rates, in FY-74 dollars, are provided for each shipyard for the period FY-70 through FY-74. These rates are computed on the same basis as the applied overhead rates, except that actual rather than estimated costs and direct labor hours are used.

a. Interpretation

In Chapter IV, three performance indicators involving overhead costs were defined--overhead cost per direct manday expended, ratio of overhead to total cost, and the ratio of overhead to direct costs. It was pointed out that the primary value of these indicators was in identifying significant trends that might provide management the opportunity to improve the overall operation of shipyards. The actual overhead rates in Table 38 can also be used for trend analysis but from a different, and

Table 38. ACTUAL OVERHEAD RATES IN NAVAL SHIPYARDS, FY-70 THROUGH FY-74
(Overhead Dollars Per Direct Labor Manhour, Constant FY-74 Dollars)

	FY70	FY71	FY72	FY73	FY74
Boston					
Production	2.673	2.960	2.645	2.615	*
General Manufacturing	1.666	2.023	2.065	2.179	*
General Administrative	2.059	2.475	2.628	2.767	*
Charleston					
Production	2.696	2.813	3.098	2.966	3.101
General Manufacturing	1.835	2.017	2.394	2.377	2.390
General Administrative	1.989	2.212	2.571	2.394	2.225
Hunters Point					
Production	2.803	2.819	2.736	3.029	*
General Manufacturing	2.113	2.292	2.289	2.566	*
General Administrative	2.335	3.167	3.108	3.469	*
Long Beach					
Production	2.153	2.156	2.129	2.246	2.187
General Manufacturing	1.229	1.186	1.235	1.396	1.501
General Administrative	1.484	1.588	1.637	1.952	2.193
Mare Island					
Production	2.892	3.043	2.300	2.990	3.361
General Manufacturing	1.758	1.899	2.133	2.274	2.611
General Administrative	2.337	2.215	2.601	2.565	2.702
Norfolk					
Production	2.539	2.530	2.669	2.683	2.937
General Manufacturing	1.597	1.766	[illegible]	1.881	1.900
General Administrative	1.732	1.974	2.228	2.515	2.476
Pearl Harbor					
Production	[illegible]	2.831	3.004	3.150	3.038
General Manufacturing	2.023	2.075	2.238	2.550	2.394
General Administrative	1.752	1.823	2.143	2.550	2.399
Philadelphia					
Production	2.124	2.254	2.681	2.679	2.417
General Manufacturing	1.334	1.678	1.753	1.566	1.706
General Administrative	2.089	2.079	2.208	2.228	2.306
Portsmouth					
Production	2.682	2.924	2.963	3.133	3.168
General Manufacturing	1.667	1.974	2.441	2.729	2.866
General Administrative	1.791	1.943	2.323	2.734	2.866
Puget Sound					
Production	2.855	3.191	3.331	3.668	2.877
General Manufacturing	1.680	2.073	1.963	2.277	1.791
General Administrative	1.531	1.678	1.841	2.012	1.678

*Not reported for FY-74 due to closure.

Source: Derived from the "Fractionated Actual Composite Overhead Rate." Exhibit to the *FAO Statements* as of June 30 for each year shown.

somewhat limited, viewpoint. The only advantage in using these overhead rates, rather than the indicators in Chapter IV, is that the Navy routinely publishes actual overhead rates in the *F&O Statements*. Thus no computation is required before trend analysis can be performed.

As shown in Table 38, naval shipyard overhead rates, even in constant dollars, generally increased over the time period displayed. Whenever rates decreased, the decrease was usually small and resulted in only a brief interruption in the overall upward trend. The most notable decrease was at Puget Sound in FY-74.[1] This was the only instance in which all three overhead rates decreased in the same year for any shipyard. Many variables operate to effect such a change; however, the underlying reason was the large increase in direct labor hours expended during FY-74. This increase reflects a management decision to concentrate on hiring mechanics in the FY-74 total employment increase. Of approximately 1,400 new hires, over 1,000 were mechanics. This increase ultimately resulted in an increase of 2.5 million direct labor hours expended in FY-74 compared with FY-73. As a result, overhead costs were spread over a larger number of direct labor hours, which resulted in a lower rate.

The single year decline in the general manufacturing rate at the Philadelphia Naval Shipyard provides another example of how monitoring variations in overhead rates can be used to focus management attention on areas that might require investigation.[2]

[1]The cost-per-manday indicators in Chapter IV, of course, reflected this same trend. The essence of that discussion is repeated here to illustrate how different indicators can be used to monitor vital parameters.

[2]This discussion is limited to an analysis of variation in the general manufacturing rate only to illustrate how overhead rates can be used to pursue specific areas of concern. A detailed investigation of this situation would require extensive review of all shipyard overhead costs since the variation in total overhead costs over this five-year period was quite different. As shown in Figure 38, FY-72 and FY-74 total overhead costs per direct manday expended were somewhat higher than for the other years displayed. This could be the result of shipyard closure rumors that may have caused less efficient use of the shipya d in those years.

In this instance, the decrease in the total general manufacturing rate could be attributed to three cost classes (lost time, defective work, and shop stores) within the production general cost center.[1] An examination of actual overhead costs for these cost classes showed that for all years, except FY-73, total expenses charged comprised about the same percentage of total overhead expenses. Charges in FY-73 were significantly lower. Clearly, a thorough analysis would be required to identify all of the factors that led to this situation. One important factor was identified in IDA discussions with shipyard personnel. In FY-73 there was increased management emphasis on reducing the amount of time charged to these "non-productive" cost classes. The fact that the time charged to two of the three cost classes returned to earlier levels in FY-75 may indicate that improvements were only temporary.

b. Comparison With Applied Overhead Rates

The overhead rates in Table 38, as noted above, are computed on the same basis as applied overhead rates, except that actual labor hours are used.[2] Thus, the rates shown are historical in that they are never used by the shipyards to bill customers. These actual rates are the rates that, had they been used throughout the year, would have recovered exactly the total overhead costs for each of the three overhead categories.

The rates shown for the general manufacturing and general administrative overhead categories are directly relatable to the corresponding applied overhead rates since a single applied overhead rate is used for each category. The rates for the production overhead category must, however, be interpreted in

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[1]This cost center was established to accumulate specific department-wide costs that are not considered chargeable to individual shops.

[2]See Appendix N.

a different way. Throughout the year, each production center uses its own applied overhead rate. As a result, the single composite production overhead rates in Table 38 are not directly relatable to the applied rate for any one cost center.[1]

2. Composition of Overhead Rates for Naval Shipyards

To provide insight into the composition of overhead in naval shipyards, each of the three overhead categories in Table 38 was examined in terms of percentage accounted for by its major components. The results are displayed in Table 39.[2]

a. Production Overhead Costs

In the NIF cost accounting system, the use of cost classes to provide detail of overhead costs for all production centers is mandatory. Hence, detailed data at this level are routinely available. Of over forty cost classes identified for production overhead costs,[3] eleven classes account for over two-thirds of the total production overhead cost. In Table 39, these eleven classes have been grouped into major categories to focus attention on four important functional areas:

(1) Supervision--includes the overhead costs of both general-schedule and wage employees performing supervisory duties. Under NIF procedures, all supervisors are charged to overhead except when performing the same task as other employees assigned to a job order.

(2) Training--includes the overhead cost of apprentice, nuclear, and non-nuclear formal training. Apprentices are charged direct when working on direct job orders.

[1] The *F&O Statements* do provide actual overhead rates for each production cost center that can be used by managers of these centers to compare actual versus budgeted costs. The single composite rate is used to facilitate analyses at a more aggregated level.

[2] The display has been limited to FY-72 through FY-74 for the eight yards that remain open to avoid excessive computations.

[3] See Appendix N, Table N-5.

Table 39. COMPOSITION OF OVERHEAD EXPENSE IN NAVAL SHIPYARDS, SELECTED ELEMENTS AS PERCENTAGE OF THREE MAJOR OVERHEAD CATEGORIES

(FY-72 through FY-74)

	Charleston			Long Beach			Mare Island			Norfolk		
	FY72	FY73	FY74	FY72	FY73	FY74	FY72	FY73	FY74	FY72	FY73	FY74
Overhead Category (Code)												
Supervision (1,2)	40	42	41	43	45	44	46	50	46	41	40	36
Training (9,38,39)	14	11	14	14	11	11	11	9	12	14	14	18
Not Available (10,11,14)	2	2	2	2	3	4	4	6	4	2	2	6
Shop Support (4,5,12)	16	15	15	12	13	11	17	18	18	16	17	16
All Others	28	30	28	29	28	30	22	17	20	27	27	24
Total Production	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Quality Assurance (9130)	4	4	3	1	1	1	2	2	2	2	2	2
Planning (9200)	10	10	10	13	12	13	12	13	14	12	11	10
Production (9300)	13	12	12	8	8	6	10	11	10	12	11	10
Production, General (9390)	11	13	12	10	11	12	7	8	11	10	10	12
Central Tool Room (9396)	9	11	14	11	10	10	13	12	11	8	8	9
All Others	53	50	49	57	58	68	56	54	52	56	58	57
Total General Manufacturing	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Data Processing (91ic)	5	6	5	7	7	6	4	4	4	4	4	4
Shipyard General (9190)	4	2	4	5	8	12	7	4	7	8	10	11
Transportation (9420)	8	7	6	8	8	8	6	7	6	9	9	9
Maintenance (9470)	7	8	7	10	9	7	5	6	7	7	8	8
Supply (9500)	9	8	8	9	9	9	9	9	8	8	8	7
Administrative (9800)	6	6	6	5	4	4	9	9	7	6	6	5
All Others	61	63	64	56	55	54	60	61	61	56	55	56
Total General Administration	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

	Pearl Harbor			Philadelphia			Portsmouth			Puget Sound		
	FY72	FY73	FY74	FY72	FY73	FY74	FY72	FY73	FY74	FY72	FY73	FY74
Overhead Category (Code)												
Supervision (1,2)	44	46	46	39	38	39	40	39	43	[illegible]	43	44
Training (9,38,39)	16	12	13	7	9	8	6	9	8	10	11	12
Not Available (10,11,14)	1	[illegible]	1	2	2	3	2	1	2	8	8	9
Shop Support (4,5,12)	13	13	13	18	18	17	17	17	16	17	18	18
All Others	26	28	27	34	33	33	35	34	31	28	20	17
Total Production	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Quality Assurance (9130)	3	3	3	2	3	2	5	5	4	3	2	2
Planning (9200)	14	14	17	13	12	12	15	15	14	12	14	14
Production (9300)	15	13	11	7	7	6	13	12	12	15	16	16
Production, General (9390)	11	11	11	13	10	15	9	10	13	8	8	7
Central Tool Room (9396)	9	8	8	8	8	8	8	8	6	14	12	13
All Others	48	51	50	57	60	57	50	50	51	48	48	48
Total General Manufacturing	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Data Processing (91ic)	4	4	6	5	6	5	5	5	5	3	3	4
Shipyard General (9190)	3	5	5	1	1	1	3	5	4	4	5	3
Transportation (9420)	9	8	7	7	8	7	6	6	7	7	8	7
Maintenance (9470)	7	5	7	12	11	10	6	6	6	7	7	6
Supply (9500)	9	9	9	12	12	10	10	10	9	8	8	7
Administrative (9800)	6	5	5	6	7	6	6	6	6	5	5	5
All Others	62	63	61	57	55	61	64	62	63	66	64	68
Total General Administration	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Source: Derived from "Cost Center Operating Statements" in *F&O Statements* as of June 30 for each year shown.

(3) Time Not Available--includes the overhead cost of lost time, time allowed for miscellaneous tasks not covered by other cost classes, and defective work or spoilage. These three cost classes may be thought of as a drain on the resources of the production centers since time charged to these does not represent an increase in output.

(4) Shop Support--includes the overhead cost of essential shop functions that tend to increase the efficiency of the direct worker. Includes material expeditors, shop planners, and miscellaneous shop support activities.

As shown by Table 39, supervisory overhead costs generally account for over 40 percent of the total production overhead costs. This is by far the largest single functional category. The "time not available" category, on the other hand, accounts for a significantly lower percentage of the total production overhead cost. In fact, several of the yards report zero lost time at the shop level choosing instead to include these costs in the production general cost center. Even though this approach is within the latitude afforded by the NIF cost accounting system, electing to manage this potential problem area at a level higher than the shop level fails to exploit the full potential of the management system. Only if instances of lost time are routinely reported at the shop level can basic problems be indentified promptly and corrective actions initiated.

b. General Overhead Costs

The additional use of cost classes for general cost centers is not optional but is controlled by NAVSEA and is limited to a few cost centers.[1] As a result, detailed information for these centers in Table 39 is limited to the cost center level. As with production overhead costs, there is in general a uniformity among the shipyards with very small changes over time for

[1]See Appendix N for listing of those centers for which detail by cost class is available.

individual yards. This is probably indicative of the manning similarity among shipyards.

Considerable caution must be exercised in using the data in Table 39 as a basis for discussing the relative composition of total overhead costs. As pointed out earlier, the data in Table 39 were converted to percentages of the three major overhead categories to focus attention on details within each category. Thus, comparison among the three major categories is inappropriate and can be misleading unless properly interpreted.

3. Using Overhead Costs and Rates to Evaluate Shipyard Performance

a. General

Considerable caution must be exercised in using overhead costs and rates to evaluate the relative performance of shipyards. This is true both for comparisons among naval shipyards and for comparisons between naval and private shipyards. Meaningful comparisons can be made only after an extensive analysis of the cost elements included in the overhead accounts and the basis against which costs are allocated. Even after this analysis, overhead costs must be interpreted in the context of total costs before meaningful conclusions can be made. This is true because the balance achieved between overhead and direct costs is not a measure of performance. The use of overhead data as performance indicators was covered in Chapter IV and will not be repeated here.

The importance of using overhead data in the context of total costs is not meant to indicate that meaningful comparisons of overhead data are impossible. Such comparisons can, however, be misleading unless properly used. The data in Table 38 can be used to illustrate this point. As shown in Table 38, overhead rates associated with production overhead costs are generally larger than the rates for the other two major overhead categories. On the surface, this would appear

to indicate that production overhead costs are greater than the overhead costs of the general centers. It must be remembered, however, that the production overhead costs are allocated only to the direct labor hours expended in production cost centers. On the other hand, general overhead costs are allocated to all direct labor hours expended by the shipyard. Thus, it would be misleading to draw a conclusion about the relative magnitudes of the various overhead cost categories without an analysis of the total cost and direct labor hours for each category.[1]

b. Problems in Comparing Overhead of Private and Naval Shipyards

Comparison of overhead costs among naval shipyards is facilitated by the standard cost accounting required of NIF activities. Minor variations occur among the shipyards but these are not of sufficient degree to distort the analysis. As explained earlier, however, direct comparison of overhead costs even for naval shipyards is inappropriate as a basis for assessing the relative performance or efficiency of the yards. Too many variables are involved. In addition to differences in wage rates and cost of materials (both factors over which the yards have no control), differences in facilities, workload, and basic mission must be evaluated. Thus, even for naval shipyards, overhead data are primarily useful for internal management.

The lack of uniformity in handling costs among private shipyards makes detailed analysis of their costs a time-consuming task. The *Armed Services Procurement Regulation*[2] identifies

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[1]A cursory review of overhead costs indicates that each of the three major overhead cost categories accounts for about one-third of total overhead costs. Use of this relationship is probably sufficient for gross comparisons of overhead costs by major category.

[2]*ASPR, op. cit.*, para. 15-201.2.

the general factors to be considered in determining the allowability of individual cost elements as reasonableness, allocatability, and consistency with generally established accounting procedures including standards promulgated by the Cost Accounting Standards Board.[1] Within this broad guidance, each shipyard develops its own accounting system. As a result, auditing private shipyard operations is focused not on whether a particular cost element is treated the same as for other yards, but on whether expenses are accumulated accurately and charged consistently in accordance with the particular system.

Disclosure Statements obtained from the Cost Accounting Standards Board were reviewed to substantiate the point that various cost elements are handled in different ways by private shipyards. In general, since 1972, all defense contractors who enter into negotiated national defense contracts in excess of $100,000 are required to submit a description of their cost accounting practices. To date, statements are on file for eight shipyards, six of which had annual total government sales in excess of $25 million for at least one year. The statements were obtained from the Cost Accounting Standards Board on the condition that any information extracted would be summarized and released in such a form as to protect fully the confidentiality of the individual reports.

The Disclosure Statements take the form of a questionnaire and provide a wealth of data on the treatment of costs in the yard. Attention was focused on Part III of the statement, which deals with several kinds of costs that are expected to be treated as direct charges by some yards and as indirect charges by others. A portion of this part of the report lends itself to tabulation as to the manner in which specific costs

[1]The Cost Accounting Standards Board was established by Public Law 91-379 as an agency of the Congress. Its purpose is to promulgate cost accounting standards designed to achieve uniformity and consistency in cost accounting principles followed by defense contractors.

are treated. Ten items were selected to demonstrate the extent to which variations exist. The results are shown in Table 40.

As shown by Table 40, variation in the treatment of costs is apparent even in the limited sample used. The most notable illustration of problems encountered is the Production Shop supervision category. Two of the yards charge all shop supervision costs as direct labor; three, as indirect; and three as either direct or indirect, depending on the actual work performed.[1] Other categories showing considerable variation in the manner treated are holiday differential, training, and computer operations. The remainder show a consistency that is probably due to the fact that the eight yards for which Disclosure Statements are filed are large shipyards. Including smaller yards and additional cost types in the sample could reasonably be expected to provide even stronger evidence of variability.

Comparisons of overhead costs and rates among private and naval shipyards are, as should be expected, even more precarious than between yards within the same sector. Some of the major differences are obvious. Other, more subtle differences are considerably more difficult to identify. Even when detailed information is available, adjusting the data to assure a valid basis for comparison requires major analytical effort.

Depending on the objective of the cost comparison, various factors must be considered to adjust costs for major differences. First, costs incurred by naval shipyards are basically those funded under the NIF and by definition, exclude many of the costs normally associated with the overhead costs of an industrial facility. Included in these non-NIF costs are such items as federal, state, and local taxes, depreciation on plant property, interest on capital, and business insurance. In addition, the pay and allowances of military personnel are

[1]The latter procedure is used in NIF cost accounting.

Table 40. TREATMENT OF SELECTED COSTS BY PRIVATE SHIPYARDS

Type Cost	Number of Shipyards Treating Cost as:			
	Direct Labor	Other Direct	Indirect	Either[1]
Health insurance	7	1		
Holiday differential	4	1	2	1
Overtime premium	6	1		1
Pension	7	1		
Shift premium	7	1		1
Training			3	5
Vacation		1	7	
In-house design engineering	6[2]			2
In-house computer operations			4	4
Production shop supervision	2		3	3

[1]Sometimes direct, sometimes indirect.

[2]Two yards treat as combined direct labor and material cost.

Source: Derived from eight Disclosure Statements obtained from the Cost Accounting Standards Board.

excluded. Many services are provided from management and technical staffs outside the yard for which the shipyard is not required to pay.[1]

The charge for work accomplished in a private shipyard is considerably more comprehensive and includes, in addition to costs incurred, an allowance for profit. Included in the overhead costs are many of the costs mentioned above--depreciation, interest, plant insurance, taxes, and an allocation of corporate expenses, if applicable. Private shipyards also benefit from many government support activities for which they do not have to pay but which are a part of the Navy's cost of ship depot maintenance. The most obvious example is the cost of long-range planning and scheduling accomplished by NAVSEA. The support provided by the SUPSHIP office is another example. Many of the services provided free-of-charge to the private shipyard (e.g., government inspection) must be accomplished in-house for naval yards and are a part of the total overhead. All of these factors must be considered and the data adjusted as needed before comparing overhead costs among private and naval yards even at an aggregated level. For comparisons at a lower level of detail, basic differences, such as definitions of cost elements and bases for allocation, must be evaluated.

Although this is not an overhead cost study, a brief effort was made to provide some insight into the relationship between overhead rates in private and naval shipyards. Unfortunately, the data available for private shipyards were limited to average hourly rates for direct labor and overhead (including fringe benefits) and could neither be validated nor adjusted. These summary-level data were provided by NAVSEA in response to an IDA request for data on private shipyards doing business

[1]The most obvious example is, of course, the cost of planning, scheduling, and workloading provided by NAVSEA.

with the Navy as of 31 December 1974.[1] From these data, a sample of 17 yards was selected--those yards with over 1,000 total employees for which both direct and overhead cost data were reported.[2] For each of the 17 yards, the ratio of overhead and fringe benefits to direct labor rates was computed.

Comparable data for naval shipyards could be derived from the *F&O Statements*. The hourly cost of direct labor was computed by dividing the total annual direct labor cost by the total number of direct labor hours to which overhead costs were allocated during the year.[3] For each, the ratio of overhead and fringe benefits to direct labor was computed

The results of this effort may be summarized as follows. For naval shipyards, average hourly overhead rates, including fringe benefits, ranged from $8.28 to $11.40. Expressed as the relationship of overhead plus fringe benefits to direct labor, the percentages ranged from 151 percent to 208 percent. For private shipyards, the ranges were $3.00 to $13.86 and 35 percent to 264 percent, respectively.

Meaningful conclusions based on such a limited evaluation are impossible. Perhaps, the only benefit to be gained from this comparison is that the results illustrate the danger of comparing overhead rates among shipyards. Also, the extremely wide range of overhead rates among private shipyards is indicative of the great variety of methods used to compute direct and overhead rates in private shipyards.

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[1]IDA Letter to Admiral Burk, Deputy Commander for Industrial and Facility Management, NAVSEA, 20 December 1974.

[2]The larger yards were selected to avoid biasing the data because of the large number of yards with few employees and to provide a sample more representative of the size of the Navy yards.

[3]Since the data for private yards included fringe benefits in the overhead rates, it was necessary to adjust the F&O labor costs. For this purpose, an average acceleration factor of 30 percent was assumed.

E. SUMMARY

Three factors, in general, cause the cost of work performed in naval shipyards to be higher than work performed in private yards:

(1) The fact that naval shipyards are required to maintain the capability and capacity to respond to a broad range of fleet-support requirements with little or no notice.

(2) The limited flexibility available to naval shipyard management to adjust employment levels in the short-run to match assigned work.

(3) The difference in wage rates between private and naval shipyards caused by the Federal Wage System.

It is reasonable to expect that the special procedures and facilities required for nuclear work will cause the cost of that work to be higher than the cost of similar non-nuclear work. The magnitude of this differential was not estimated in this study because the required detailed job order data were not made available. The limited amount of information available in the NIF F&O Statements about nuclear-unique cost centers and classes was used to gain some insight into the magnitude of nuclear-unique costs.

As pointed out in Chapter IV, the balance achieved between direct and overhead costs is not a measure of efficiency. Thus, considerable caution must be exercised in using overhead costs and rates to evaluate the relative performance of shipyards. These data are best used for management at the shipyard level to identify significant shifts in the cost of work performed.

Meaningful comparisons of overhead costs among shipyards can be made only after extensive analysis of the cost elements included in the overhead accounts and the bases against which costs are allocated. Because of the NIF cost accounting system and the amount of data routinely published for most aspects of

naval shipyard operations, it is possible to examine the overhead costs of naval shipyards in detail. Unfortunately, considerable improvement in the amount of data available about private shipyard operations must be made before in-depth analysis of the cost of work performed in these yards can be made on a routine basis.

Chapter VI

MANPOWER IN THE U.S. SHIPBUILDING AND REPAIR INDUSTRY

A. INTRODUCTION

1. Purpose

For many years prior to 1970, the U.S. shipbuilding and repair industry was plagued with unused capacity. During that period the Navy served as the shipyards' major customer.

The passage of the Merchant Marine Act of 1970, changes in the energy environment, and adjustments in foreign exchange rates have led to substantial increases in commercial shipbuilding activity. Paralleling these developments has been an expanded naval construction and overhaul program. The combined effect of these developments has been a large and sudden increase in the demands placed on the U.S. shipbuilding and repair industry. Competition between the Navy and commercial shipping firms for the shipbuilding and repair industry's limited resources is increasing. Unless the quantity of these resources can be expanded, the Navy will experience increased difficulty in placing workloads in private shipyards.

The capacity of the U.S. shipbuilding and repair industry at a point in time is a function of the type and quantity of facilities in place and manpower employed. At some (albeit loosely defined) level, employment will become facilities-constrained. That is, there exists some level beyond which no additional manpower can be productively employed. Similarly, manpower availabilities place a limit on the efficiency with which facilities can be utilized.

Early in this study it was concluded that the availability of manpower, and especially that trained in shipyard skills, is critical in determining shipyard responses to large and sudden unexpected increases in demand. This fact was emphasized in several of the studies reviewed, in responses received to the IDA questionnaire, and repeatedly by officials of several naval and private yards during the IDA study team's visit and in recent testimony before the House Seapower Subcommittee. The important role assigned to manpower implies that detailed analyses of shipyard manpower availabilities are necessary for the planning and implementation of a comprehensive national shipbuilding and repair program. Manpower is an active constraint on industrial capacity in the short run, and the magnitude as well as the mix of naval workloads placed in private yards (and by implication in naval yards) will be affected. For these reasons, the focus of this chapter is on shipyard manpower availabilities.

2. Earlier Studies of the Problem

Other studies have been made of the shipyard manpower market. However, given the importance of this market, the number of these studies has been quite small. The broadest of these previous efforts is covered in three documents published by the Mark Battle Associates as part of ongoing work being performed for the Maritime Administration.[1]

a. Mark Battle Associates Studies

Based primarily on their own surveys, Mark Battle gathered employment and related data on sixty-six private and ten naval yards (including Boston and Hunter's Point, which are now

[1]Mark Battle Associates, Inc., *Shipbuilding Manpower Study* (1974), *Gulf Coast Shipyard Manpower Survey* (1973), and "Preliminary Assessment of Manpower Availability, U.S. Construction Industry, 1975-80" (undated memorandum), Washington, D.C.

closed) located along the Atlantic, Pacific, and Gulf Coasts, in the Great Lakes region, and along inland waterways. This probably represents the broadest collection of shipyard manpower data currently available. The data covered various time periods from the beginning of calendar year 1972 through June 1973.

The first two studies provided a detailed description of the current manpower status in many of the nation's shipyards. They documented, for the first time, the large numbers of new hires, quits, discharges, and layoffs in the nation's yards. A breakout of these and other manpower-related statistics was provided by area, occupation, and type of yard (construction, repair, naval, and boat and barge).

Evidence relating to industry demands was also collected in the form of estimates by shipyard personnel of manpower requirements, by occupation, for each of the next several years. (Estimates obtained in this manner require continual revision and verification to determine their relevancy and to estimate the size and direction of bias.) These demand estimates, coupled with information on labor supply, were used to project the nature and size of the potential manpower problem in the industry. The conclusion was that "demand" for skilled manpower would increase by 8 to 12 percent per year from June 1973 through June 1975 and that "shortages" would develop or be intensified in most markets.[1] It was argued that this "shortage" was due to four factors:

- High quit and discharge rates in the yards.
- A non-competitive wage posture, which contributed to past hiring difficulties.
- Inadequacy of training programs.
- A narrowly structured wage scale.

Utilizing the data collected in their surveys, Mark Battle Associates developed "projections of productive manpower availability for selected shipyards during fiscal years 1976-81."[2]

[1] *Shipbuilding Manpower Study*, *op. cit.*, p. 132.

[2] "Preliminary Assessment," *op. cit.*, p.1.

The analysis, however, did little to assess availabilities, rather it projected new-hire rates necessary to meet predetermined employment increases for selected occupational groups.

The projections were made with the aid of the following two relations:

$$T.\ O. = A \frac{(EMP_{n+1} - EMP_n)^b}{(Un)^c} \qquad (1)$$

$$N.\ H. = \frac{(EMP_n + EMP_{n+1})}{2}\ T.\ O. + (EMP_{n+1} - EMP_n) \qquad (2)$$

where,

- T. O. = annual turnover rate (quits plus discharge);
- EMP_n = employment, base time period;
- EMP_{n+1} = employment one year after base time period:
- Un = average annual unemployment rate for the local market; and
- N. H. = total new hires for the annual period n to n+1.

Equation 1 is an hypothesized relation with turnover rates (T. O.) as the dependent variable and the change in employment (EMP_{n+1}-EMP_n) and the area unemployment rate (Un) as independent variables. The coèfficients A, b, and c were estimated by taking logarithms of each variable and using linear regression techniques on cross-section data for twelve shipyards for FY-73.

Projecting levels of the independent variables for some out year allows the expected value of T. O. to be calculated.[1]

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[1]Ultilization of relationships derived from cross-section data is suspect as a reliable approach for forecasting the impact of true structural parameters. J.L. Bridge's advanced econometric textbook on forecasting and policy applications, *Applied Econometrics* (North-Holland, New York, 1971), p. 241, cites two important cross-section forecasting studies to the effect that, first, "it must be concluded that estimates of micro or macro dynamic effects cannot typically rely on cross-section estimates" (Edwin Kuh, *Capital Stock Growth: A Micro Econometric Approach*, North-Holland, New York, 1963); and second, "it would be extremely dangerous to construe (continued on next page)

The information on employment and turnover is then used in equation 2 to calculate the expected number of new hires required to meet the projected employment level.

There are several problems with this technique that impact substantially on its usefulness. One problem concerns the reason for the relation between the change in employment and turnover rates. For simplicity, we may assume that all employees are in two groups: those most recently employed (i.e., recent new hires), and those with greater seniority. Turnover of more senior employees would be expected to be related to their alternative earning potential and largely unrelated to the rate of employment change. If so, the change in employment reflects or "picks up" the influence of the newly hired workers only. These workers tend to be younger and therefore more mobile; they may be "trying out" a job or occupation and therefore have a greater propensity to quit. In addition, most collective bargaining agreements require that if an employee is to be judged unqualified and dismissed, such actions must be accomplished in the first sixty to ninety days of employment. In other words, with quits plus discharges as the dependent variable, $EMP_{n+1}-EMP_n$ serves as a proxy for the level of new-hire activity.

Using these two equations results in a proxy for current new-hire activity being used to project turnover rates, which in turn are used to project current new-hire requirements. The utility of estimates obtained in this manner is limited since the impact of relative wages is not considered.

b. <u>OMB Study</u>

The Office of Management and Budget (OMB), in light of the increase in budget requests for shipbuilding activities,

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(cont'd) in any very literal sense the regression estimates (*based on cross-section data*) that follow as representing true structural parameters" (J.R. Meyer and R.R. Glauber, *Investment Decisions, Economic Forecasting and Public Policy*, Harvard University Press, Boston, 1964).

undertook an examination of the construction capabilities of the shipbuilding industry.[1] To assess the manpower situation, new construction workloads were forecast and compared with estimates of manpower availabilities. OMB analyzed separately the capabilities at Electric Boat, Newport News, and twelve non-nuclear construction yards.

The OMB demand projections call for 51,900 equivalent man-days by 1979 in the yards analyzed.[2] Discussions with personnel at the Office of Ship Production, NAVSEA, who aided in the preparation of these estimates indicate that these projections may be in error. Much of the construction activity from the Construction Differential Subsidy (CDS) program, was estimated to begin sooner than could be realistically expected. If so, the rate of buildup in manpower demands is overestimated.

To estimate the "potential available workforce," the "near-term and previous manpower buildups, as well as yard policies concerning manpower levels," were reported to have been taken into consideration. The achievable work force in these yards was estimated to be 35,000 equivalent men, which would leave a shortfall of 16,900 by 1979.[3]

Because of the possibility of error in OMB's demand projections, this shortfall may be overestimated. More importantly, it is not clear whether the 35,000 "available" equivalent men is constrained by labor market characteristics or by physical capital and plant facilities. Discussions with personnel at OMB indicate that the 35,000 figure represents the sum of previous sustained peak employments in each shipyard or shipyard estimates of optimum manning levels, whichever is lower. If so, labor market conditions played no role. The 35,000 figure is probably facilities-constrained and is then an estimate of

[1]Office of Management and Budget, *Shipyard Capabilities Study*, unpublished working paper, Washington, D.C., September 1974.

[2]*Ibid.*, p. 119.

[3]*Ibid.*, p. 118.

maximum potential demand for labor and not supply. The short fall, as calculated by OMB, cannot then be used as an estimate of a manpower shortage.[1]

c. OASD/PA&E Study

The Office of the Assistant Secretary of Defense for Program Analysis and Evaluation conducted an investigation into the building capabilities of the Newport News Shipbuilding and Drydock Company.[2] The study concluded that "there is every reason to suspect that the yard will be unable to meet the manpower requirements of the proposed ... program at current wage rates."[3]

The study conclusion was based on the following evidence. From 1960-73, the employment history of the yard was marked by severe peaks and valleys. Many of the workers who were laid off during these cutbacks found jobs elsewhere and were not available for recall during the following buildup. New hires and the ensuing recruiting efforts were needed.

At the time the study was conducted, employment at the shipyard in Newport News was equal to 27 percent of the area civilian employment. If employment in the shipyard rose to 30 percent of that available in the area, which had been the case from August 1961 through May 1962, manning requirements could have been met. In other words, there was no physical shortage of trainable workers.[4] The yard was also engaged in

[1]A shortage is defined as the demand for manpower exceeding its supply at prevailing prices.

[2]The study made available to IDA is an untitled, undated first draft, with a cover letter from the Office of the Director of Defense Program Analysis and Evaluation (Resource Analysis), noting the subject to be "Newport News Shipyard Sub-Building Capacity," and dated June 22, 1973.

[3]*Ibid.*, p. 1.

[4]*Ibid.*, p. 13. It should be noted that this conclusion does not take into account the potential effect of changes in the area's industrial structure between 1962 and 1974 on the labor market.

an intensive recruiting effort. In fact, it was reported that recruiters were combing areas extending from the Carolinas to Pennsylvania.[1] In addition, minority employment was being increased.[2]

The need for extensive recruiting efforts, coupled with the apparent physical availability of manpower, suggested that the shipyard's wage rates were non-competitive. The evidence presented showed that wage rates for skilled mechanics averaged between 50 and 55 percent of the prevailing hourly rate for similar skills in the area construction industry.[3] Similarly, hourly wages for unskilled (laborers) and semiskilled (helpers) workers in the yards were found to be between 50 and 60 percent of the area rate in construction.[4]

d. Evaluation

In summary, some effort has been made in recent years to analyze manpower problems in the nation's shipyards. The studies that have been done are invaluable in that they provide important background information on the shipyards and bring into sharper focus some of the constraints operating on shipyard manpower supply and demand. These studies, however, do not address explicitly several important questions:

- Does a skilled manpower shortage exist?
- If so, is it transitional or long run in nature?
- To what extent are the hiring difficulties and high quit-discharge rates influenced by the industry's wage posture?

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[1] *Ibid.*, p. 15.

[2] *Ibid.*, p. 14.

[3] *Ibid.*, pp. 25-27.

[4] *Ibid.*, pp. 22-24.

3. Analytic Approach

The approach used in this analysis is to view shortages as the usual phenomenon that occurs in a marketplace when demand increases more rapidly than supply and prices do not instantaneously adjust. The existence of a manpower shortage means that some type of adjustment has to be made by employers. The time element of shortage then can be investigated. In addition, turnovers, especially quits and discharges, layoffs, rehires, and new hires are viewed as being dependent on the market conditions leading to a shortage.[1]

In particular, the intent of this chapter is to determine--

(1) The extent to which a shortage of shipyard manpower can be expected.

(2) The nature and characteristics of the shortage (if one is found to exist).

(3) The role of wage and non-wage factors that affect the availability of manpower to the shipyards.

(4) Possible actions available to the Office of the Secretary of Defense to better assure the completion of naval workloads and to increase the cost-effectiveness of shipyard work.

Though this analysis was undertaken to determine the impact of the shipyard manpower market on naval work, for analytic purposes one cannot legitimately isolate this segment from the total industry demand. If a shortage exists, it is because *total* manpower demand exceeds *total* manpower supply in shipbuilding. It is possible, however, to provide incentives that will assure naval work a first-priority rating and thrust any shortage on commercial work. While the efficiency of such incentives must be questioned, it is unlikely that such a policy would be feasible at this time.

Similarly, the regional aspects of demand were not examined. If the demands on shipyards in a particular region exceed that

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[1]The definition of each of these types of turnovers is given in the Glossary section of this volume.

region's capabilities, some of the workload is likely to migrate elsewhere. For example, there currently are only three private yards with the facilities to do nuclear-related work. If the *total* demand on the facilities of these yards exceeds the work that can be expected to be performed in a reasonable time, some of the non-nuclear customers will tend to go elsewhere.

Consequently, this analysis was conducted from an industry view. All workloads, naval and commercial, new construction and depot maintenance, were combined and are referred to as total industry demand.

The analysis of the market for shipyard manpower makes up the remainder of this chapter and is organized as follows: Section B discusses the concept of economic shortage, because of the vagueness with which the term shortage is often used. Explicitly defining the term provides the reader with insights into the various phenomena that coincide with a shortage and the type of adjustments that alleviate it. The discussion also includes an analysis of the interrelated roles of labor supply elasticity, hiring, and manpower retention (turnover). Much of the analytical core of this section is taken from a paper by Kenneth J. Arrow and William M. Capron.[1] Section C provides evidence bearing on the existence of a shortage of shipyard manpower. The discussion deals with factors relating to total industry manpower demands and supplies and shipyard wage rates.

Section D describes individual shipyard manpower markets. This includes factors such as wage rates in individual labor market areas, the collective bargaining structure, other industries competing for shipyard manpower, and shipyard turnover by region and occupation. In Section E, the results of an economic analysis of turnover rates are presented and

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[1]Kenneth J. Arrow and William M. Capron, "Dynamic Shortages and Price Rises," *Quarterly Journal of Economics*, LXXIII, 2, May 1959, pp. 292-308, reprinted in Donald S. Watson, *Price Theory in Action*, Houghton Mifflin Company, Boston, 1973, pp. 340-50. All page references refer to the reprint version.

discussed. The purpose here is to quantify the influence of shipyard wage rates on shipyard turnover. A summary, including conclusions and policy recommendations, constitutes Section F.

B. SHORTAGES: THE DYNAMICS AND EMPIRICAL PARAMETERS OF LABOR MARKET ADJUSTMENTS

A "shortage" is a market phenomenon that exists when people want to buy more of a product than is being supplied at current prices. It is frequently used as a synonym for "scarcity," but such usage is incorrect because shortage and scarcity describe different circumstances.

A shortage is a situation involving market adjustments through prices, and in a free market all shortages tend to be temporary. In the aggregate, scarcity is a permanent physical fact of nature involving finite limits to the known quantities of resources.[1]

Applying the distinction between scarcity and shortages to manpower evaluations, the following perspectives emerge:

- Manpower is a "scarce" resource, just like aluminum and iron and petroleum.
- At any point in time, there is a finite limit to the maximum manpower available.
- Over time, there is a finite limit to the maximum possible increase in manpower.
- Manpower "shortages" in a particular industry are temporary market conditions.
- Even though manpower scarcity is a permanent fact, manpower shortages can be eliminated by market adjustments.

Clearly, it is necessary for analytic purposes that the term shortage and the context in which it is used be defined and explicitly stated.

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[1] Scarcity is permanent for all resources taken in the aggregate, but it may disappear for any one particular resource. If people change their tastes and preferences and no longer desire a resource then it is, by definition, no longer scarce.

The interest in this analysis is restricted to the supply of shipyard manpower. Demand will therefore be taken largely as a datum, and those factors that influence it will be largely ignored. The question raised is does a shortage of manpower for private and naval shipyards in the United States exist, and if so, what are its parameters? The analysis is market oriented.

1. Definition of Shortage

The equality of supply and demand is a central tenet of general economic theory, not as a state holding at every instant in time, but only as the end result of a process of adjustment. The inequalities between supply and demand are an integral part of the process by which both price and quantity adjust to equilibrium positions. A shortage, as a state of disequilibrium, exists whenever demand exceeds supply.

The terms supply and demand are used here to mean the aggregate of decisions made by firms and individuals at alternative prices in a given market. At any given moment, the choice made by a firm or individual is optimal from its point of view with its available information, but over time additional information may produce different choices. Over time, errors will be corrected and each firm and individual will move to increase its own welfare. The process of learning, correcting errors, and adjusting is an integral part of the process by which a market arrives at equilibrium. This is illustrated by Figure 41, the usual price-quantity diagram. If P_1 is the price on the market, the volume demanded (q_D) is greater than that supplied (q_S). A shortage exists.

Any increase in the price, toward P, will lessen the shortage, and an uncontrolled market will eventually eliminate the shortage. The higher price will increase the attractiveness of this market to suppliers and, thereby, lead to an increase in the quantity supplied. Although demanders will now be able to purchase (or hire) larger quantities, the total quantity

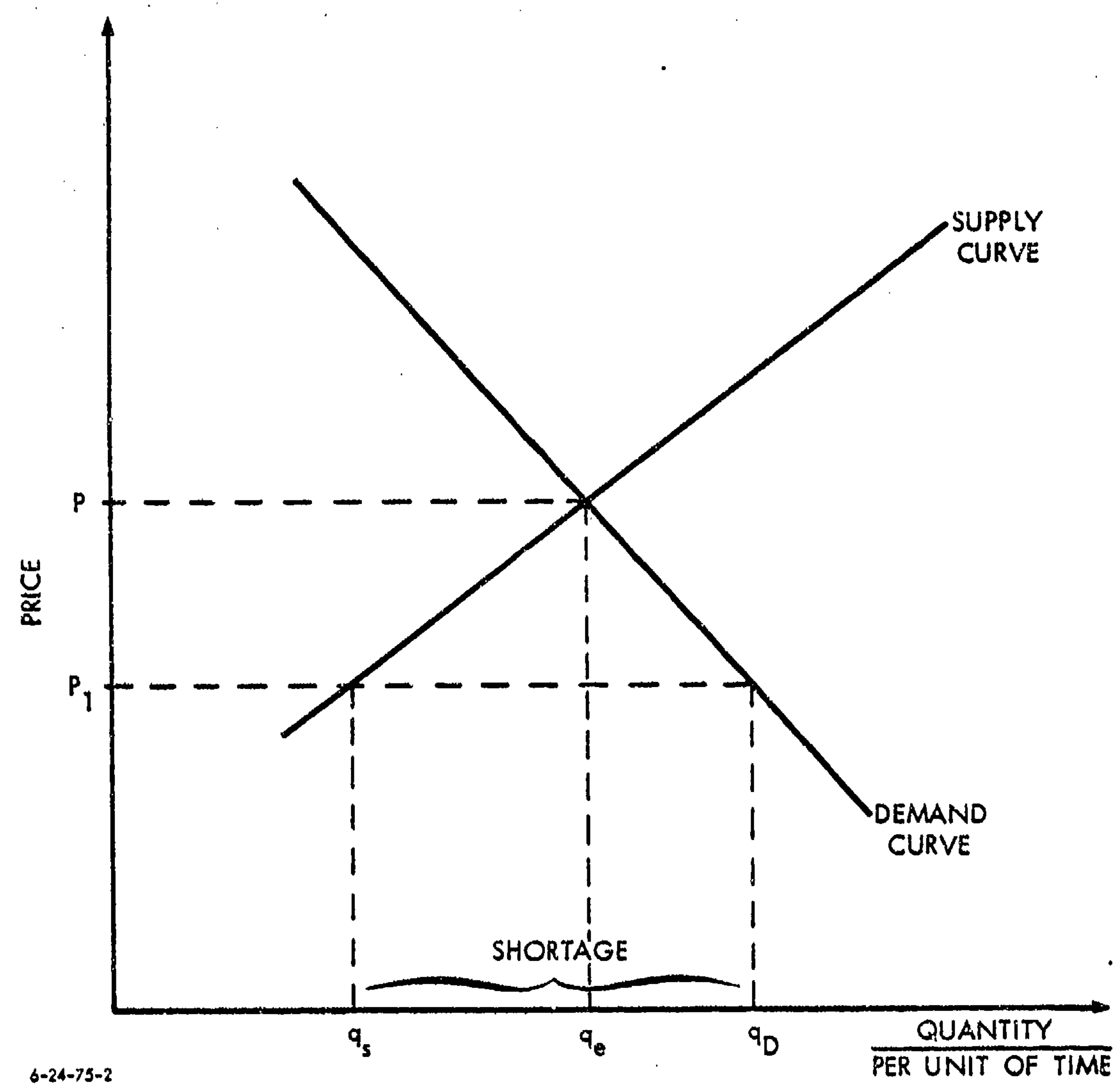

Figure 41. TYPICAL PRICE-QUANTITY RELATIONSHIP, DEMAND VERSUS SUPPLY

demanded at the successively higher prices will decline. This process will reduce the size of the shortage until price P is attained. Here the shortage will be eliminated and the market will be cleared. The shortage will persist if the prevailing conditions of demand and supply remain constant and price is held at a level below P, or if the demand and supply conditions change.

Now suppose the market is initially in equilibrium (Point A at price P_1 in Figure 42) and the quantity demanded (q_{d_0}) equals the quantity supplied (q_{s_0}). Assume this is the market for skilled blue collar workers. Suppose further that the demand for the services of these workers has increased from D_0D_0 to D_1D_1. Under these new conditions, the sum of the number of workers each firm is willing to hire at the old wage rate has increased from q_{d_0} to q_{d_1}. At any given moment, each firm may not be aware of exactly how many workers it needs (its exact demand) or the actions necessary to hire some additional number. Each firm is even less aware of the exact number that other employers in the area or the industry may desire. Each firm will attempt to hire more workers at the prevailing wage (P_1) and, clearly, not all will be successful. As long as the conditions portrayed in Figure 42 remain, including the retention of wage levels at P_1, a shortage evidenced by the existence of unfilled jobs will persist ($q_{d_1} > q_{s_0}$).

2. The Adjustment Process

The existence of a labor shortage, evidenced by unfilled job vacancies, is disturbing to management if only because it represents an additional constraint on industrial activity. The actions taken to remedy this situation are likely to differ among firms and industries and through time, based upon the type of labor in shortage, the state of the aggregate economy, and whether the increase in demand is viewed as short or long lived.

The discussion here deals exclusively with actions taken to alleviate a shortage of skilled labor. It is assumed that the aggregate economy is growing, but that full employment is not realized. In addition, each firm is assumed to react individually to this situation.

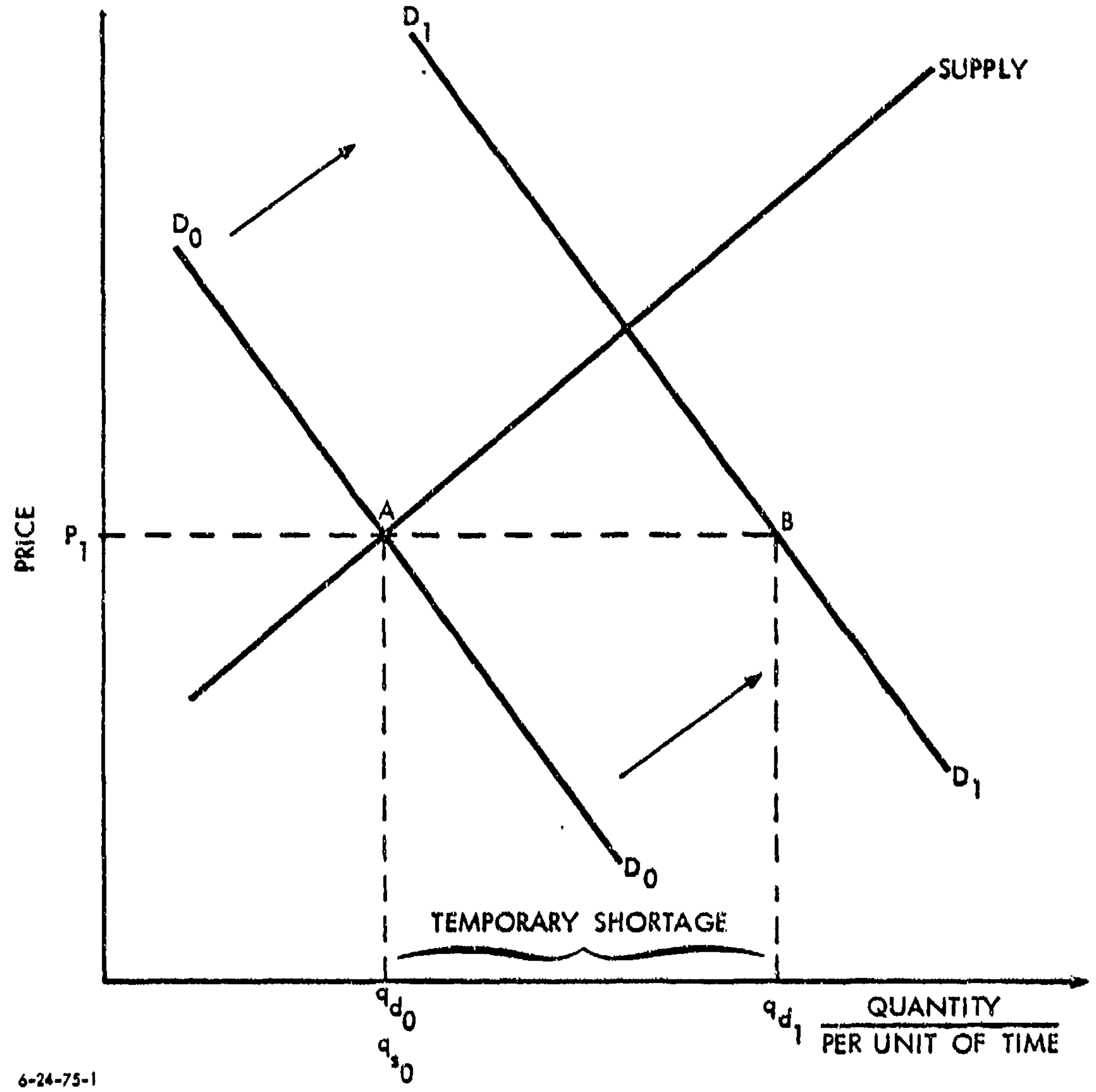

Figure 42. TYPICAL PRICE-QUANTITY RELATIONSHIP, DEMAND VERSUS SUPPLY, WHEN AN INCREASE IN DEMAND HAS OCCURRED

If the demand increase is viewed as being temporary, then only a short-run, largely reversible labor market policies will be expected. Overtime may become commonplace. Unfilled orders can be expected to grow with little increase in capacity to meet them. As the fear of order cancellations grows, subcontracting activities will increase. As demand recedes, these activities and cost return to their previous levels.

If contrary to expectations, the demand increase persists, or if it was originally viewed as being long lived, other adjustments are in order. These require that the firm expand to be able to produce larger quantities in an efficient manner. One possibility is for the firms to raise wages. It is difficult, however, to offer higher wages to newly recruited workers while still paying the current lower wage to those presently employed, so complicated wage adjustments are in order.

Since wage increases in response to a labor shortage take time, the excess of demand over supply will persist while the market adjusts. There are, however, some common approaches that will minimize the wage-rate effect. One requires reclassifying the job content or job structure. For example, if the firm presently has three classes of mechanics, it may define a new superclass to be paid a wage rate above the current first-class rate. Some of the current employees may be promoted to this class, and many new employees can be hired into it.

As an alternative, the firm may actively engage in skill dilution, i.e., substituting less-skilled workers for the skilled ones in shortage. This also will require some alteration of job structure or content. Less-skilled workers, as a whole, will take on some of the more mundane tasks previously performed by the skilled workers. The skilled workers may now have a greater supervisory function. Skill dilution may, furthermore, be viewed as a temporary move, as the firm actively trains less-skilled workers to eventually become skilled. Training of this type, however, can take from two months to six years, depending on the skill involved and the ability of the trainee, and its costs vary accordingly. In addition, a period of shortage is marked with non-uniformity of wages (or prices). Low-wage firms, or firms that have not yet raised their wage to the area level, will find workers toward the end of the training program quitting for higher paying jobs elsewhere.

3. Shortages and the Skill of the Work Force

With any sudden increase in demand, there is always the potential for manpower shortages. This potential increases with the skill content of the desired work force.

Unemployment rates by occupation tend to fall as skill content rises. For instance, the economy-wide annual employment rate for blue collar craft and kindred workers was 4.3 percent in 1972 and 3.7 percent in 1973. In these same years, the unemployment rates for (semiskilled) operatives were 6.9 percent and 5.7 percent, respectively.[1] In other words, the pool of available unemployed but possibly qualified workers diminishes as skill requirements increase.

In addition, the set of desirable characteristics for semiskilled workers includes features such as tidiness, punctuality, and possibly, education, but only rarely formal training. The recruiting and screening efforts involved in hiring additional semiskilled workers are such that under conditions of less than full employment simple and rapid adjustments can take place.

4. The Role of Turnover

A labor shortage can manifest itself not only in the inability to hire but also in the inability to retain. Since we may assume that higher wages increase the ability of the firm to hire workers, reduce quit rates, and reduce discharges by increasing the general quality of the new hires, turnover will be a decreasing function of the wage rate. The subject of turnovers is examined in Section E below.

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[1]U.S. Department of Labor, Bureau of Labor Statistics, *Handbook on Labor Statistics, 1974*, Government Printing Office, Washington, D.C., Table 65, p. 155.

5. Summary

Shortage, as used here, is a market condition wherein the quantity of labor demanded at prevailing wage rates exceeds that which can be attracted and retained.

Elimination of a shortage requires actions by the firm aimed at raising wages, restructuring supply (e.g., substitution of less-skilled for skilled workers), and increasing supply (e.g., training programs). Being profit-oriented institutions, firms will seek the least costly combination of activities. The needed actions, however, will not occur immediately. Since adjustments are costly, time must be spent in learning about the new supply conditions in the market and in determining the profitability of hiring under these new conditions. Approval of proposed actions must be obtained from the various echelons of management and then orders must be issued. The uncertainties surrounding the size of the needed adjustment, combined with the cost of errors in judgment, lead to delays in actions. Even after the actions are taken, the more skilled the desired work force, the longer the time period needed to adjust supplies.

C. EMPIRICAL EVIDENCE OF MANPOWER SHORTAGES

In this section data are presented to identify the existence of shortages of manpower in the shipbuilding and repair industry. The section begins with an historic perspective of the industry and then discusses recent events expected to affect the industry's workload. Shipyard manpower demands are projected and then coupled with analyses of wage rates and labor supplies. Finally, conclusions as to the potential size and nature of shortages of shipyard manpower are presented.

1. Activity (Demand) in the Shipbuilding and Repair Industry

Over the fourteen-year period 1960 through 1973, employment in the private yards averaged a moderate 1.6 percent annual growth; however, the increase was not smooth. Coincident with U.S. involvement in Viet Nam, employment in the yards increased rapidly during the early part of this period, reaching a post-World War II peak of 144,000 in 1966. With the Viet Nam disengagement, employment fell. By 1971, it had receded to less than 90 percent of the previous peak.

In recent years, the size of both the commercial and naval fleets has also been reduced. In 1968, there were 976 active vessels in the U.S. Navy. By 30 June 1975, the number had fallen to 497. The active U.S. commercial fleet peaked at 1,013 in 1969 and had fallen to 590 in 1974.[1]

As indicated in Figures 43 and 44, the Navy was the industry's major customer in the 1963-74 period. Naval work accounted for as much as 75 percent of new construction activity. In addition, roughly one-third of the Navy's ship overhaul and repair work was done in private yards.

Table 41 and Figure 43 indicate that shipwork has again begun to increase. This is due not only to the large number of ships now being built, but also to the larger size and greater technical complexity of today's vessels. As a result, each ship requires more time and consumes larger quantities of human and physical resources to build and repair.

a. Commercial Activity

Recent increases in commercial ship construction activity have resulted in backlogs that reach post-World War II peaks. Four factors are generally credited with causing this turnabout.

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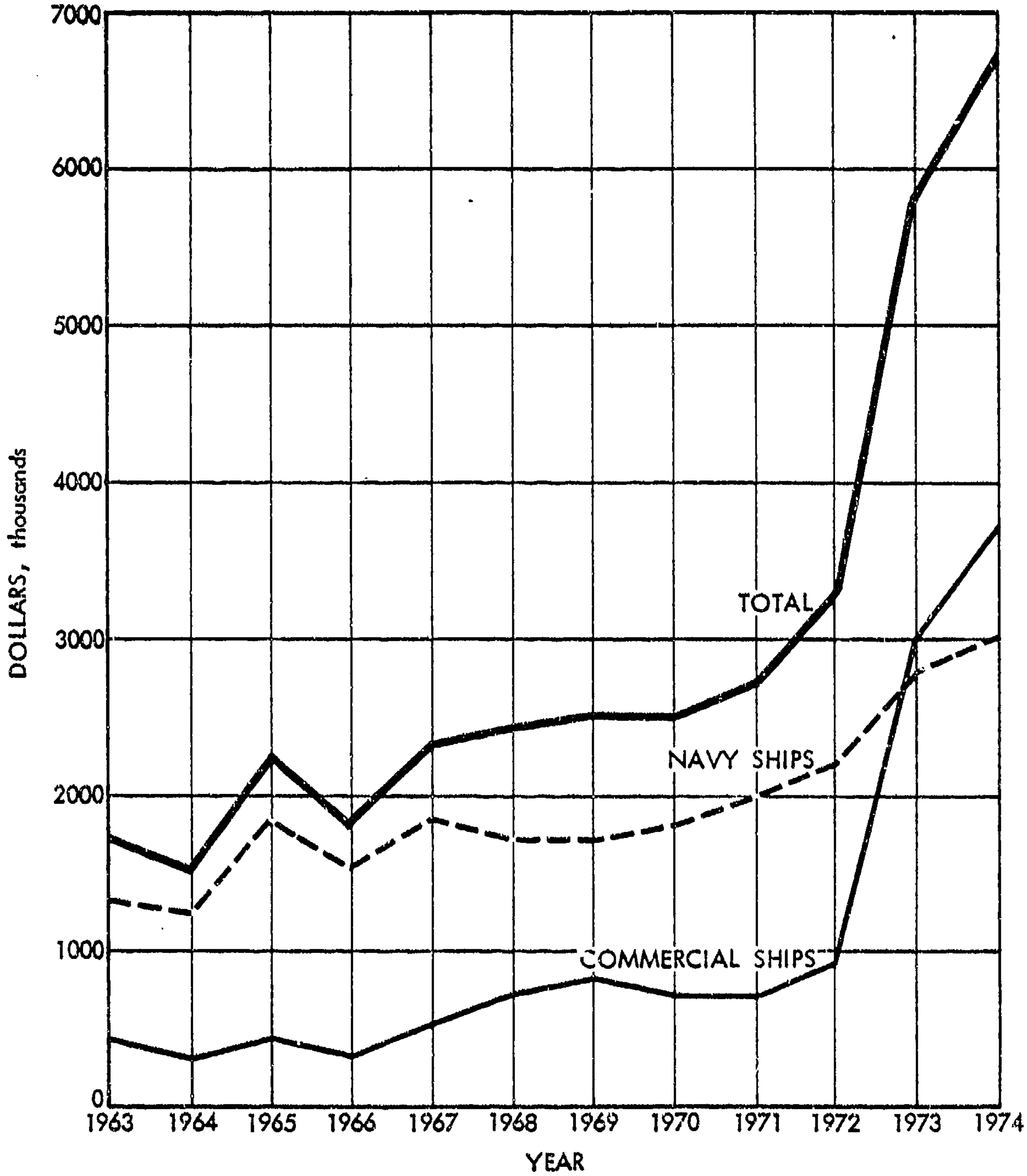
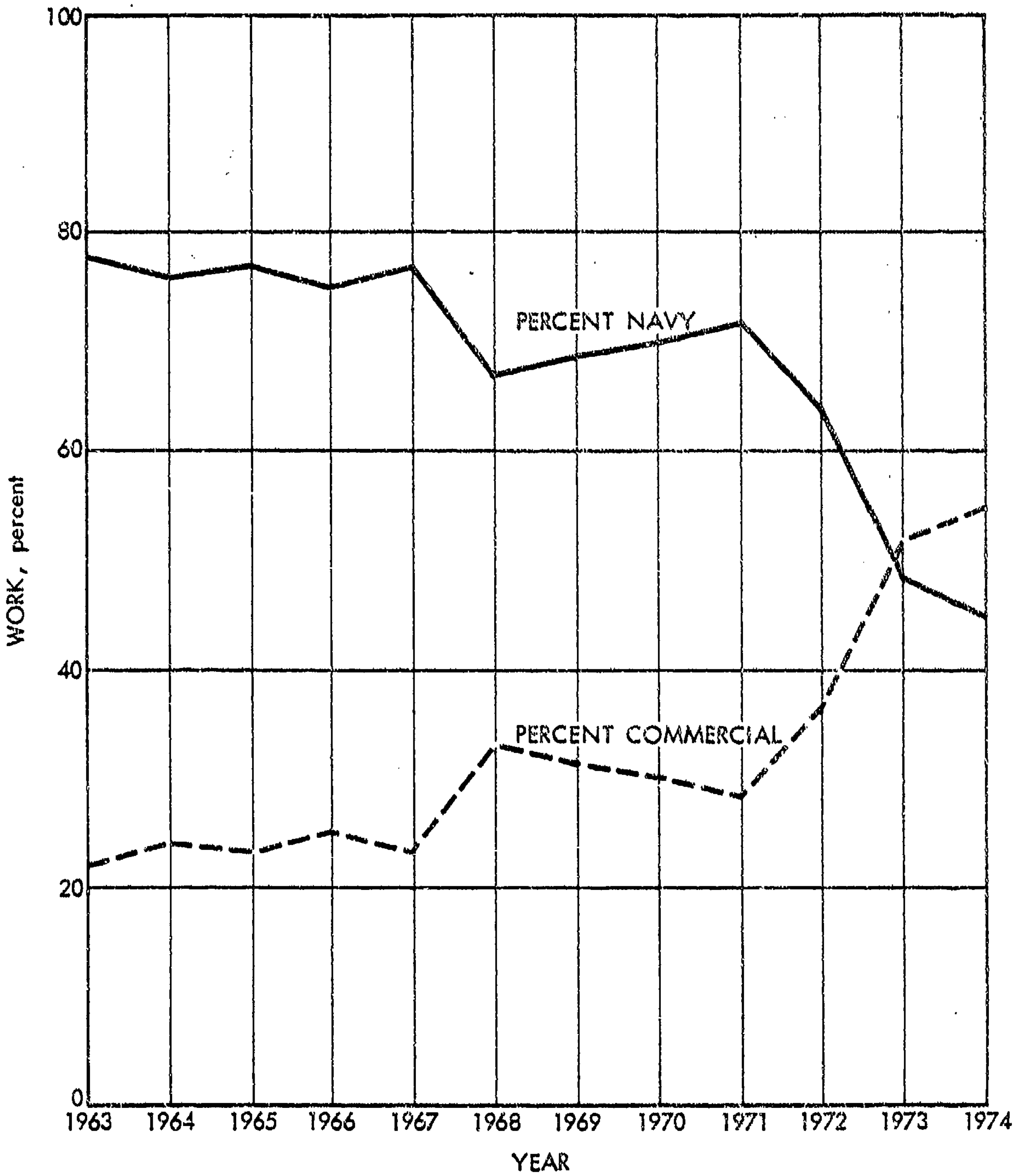
[1]U.S. Congress, House, Hearings before the Seapower Subcommittee of the Committee on Armed Services, *Current Status of Shipyards--1974*, 93rd Cong., 2nd sess., July-October 1974, Part 2, pp. 625-26.



Source: Office of Management and Budget, Shipyard Capabilities Study, Unpublished Working Paper, September 1974, Washington, D.C.

Note: Ongoing Unfinished Private Shipyard Work is Based on the Value of Shipyard Orders Undelivered, and the Amount of Costs Accumulated on those Orders. Costs are in Current Dollars.

Figure 43. VALUE OF ONGOING UNFINISHED PRIVATE SHIPYARD WORK, AS OF 1 JANUARY FOR EACH YEAR



Source: Office of Management and Budget, Shipyard Capabilities Study, Unpublished Working Paper, September 1974, Washington, D.C.

Note: Ongoing Unfinished Private Shipyard Work is Based on the Value of Shipyard Orders Undelivered, and the Amount of Costs Accumulated on those Orders. Costs are in Current Dollars.

Figure 44. PERCENTAGE DISTRIBUTION OF ONGOING UNFINISHED PRIVATE SHIPYARD WORK, NAVY VERSUS COMMERCIAL

Table 41. PRIVATE AND NAVAL SHIPYARD EMPLOYMENT, IN MANYEARS, 1955-73*

Year	Private Shipyard Employment (In thousands)	Naval Shipyard Employment (In thousands)
1955	101.3	112.1
1960	114.3	95.6
1965	127.1	81.7
1966	136.8	81.8
1967	139.0	86.7
1968	140.4	93.8
1969	143.0	90.0
1970	139.5	85.2
1971	128.7	76.4
1972	131.0	71.4
1973	137.1	65.5

*Private shipyard employment is presented on a calendar year basis, whereas naval shipyard employment is presented on a fiscal year basis.

Source: U.S. Congress, House, Hearings before the Seapower Committee of the Committee on Armed Services; *Current Status of Shipyards--1974*, 93rd Cong., 2nd sess., July-October 1974, Part 1, p. 27.

The first is the Merchant Marine Act of 1970. While the Act reduced the construction subsidy paid to shipping lines, it extended subsidies to bulk carriers and allowed for negotiated contracts. This last feature allows shipyards to negotiate with several shippers, which can result in large production runs of similar ships. Hopefully, this will lead to improved shipyard scheduling, greater learning, and increased productivity.

Second, is the realignment of foreign exchange rates. The devaluation of the dollar vis-à-vis the currencies of most other industrial nations increased the competitive position of all U.S. producers, including the shipyards.

Third, ships are now larger and more complex. The result is that labor costs as a percentage of total new construction costs are falling. Wages have become less important as a determinant of overall competitive position.

The fourth factor is the change in the energy market. The route of the Alaskan pipeline will necessitate transporting oil from Valdez, Alaska, to various other coastal ports. Since this involves intra-coastal trade, the Jones Act of 1921 requires that these cargoes be carried in U.S.-built bottoms. The overall energy shortage has led to projected increases in domestic consumption of imported liquefied natural gas and greater offshore exploration. Both will result in greater shipyard activity since offshore drilling rigs and various types of support vessels are built in the shipyards. Furthermore, secular increases in energy use, combined with higher prices, have stimulated demands for larger crude oil carriers as a means of reducing unit transportation costs.

The current status of the CDS Program, as provided by the Maritime Administration, is displayed in Table 42. Since 1970, commercial shipyards have built 41 ships under this program. There are 51 ships currently under construction,[1] and the Maritime Administration reports that it is considering 57 applications for construction of an additional 153 vessels.

b. Naval Activity

Navy ship construction is also increasing. In the five-year period 1968 through 1973, the Navy construction program

[1]Computed from U.S. Department of Commerce, Maritime Administration, *Shipbuilding Progress Report*, Report No. Mar-5110, Washington, D.C., 31 March 1975.

Table 42. VESSELS CONSTRUCTED IN CONJUNCTION WITH CONSTRUCTION DIFFERENTIAL SUBSIDY (CDS) PROGRAM, 1970-74

Year	Number of Vessels
1970	3
1971	6
1972	5
1973	14
1974	13

Source: U.S. Department of Commerce, Maritime Administration, Office of Subsidy Contracts, Washington, D.C.

averaged 10.4 ships per year.[1] In each of the fiscal years 1974 and 1975, the Congress authorized funds for eighteen combatant vessels.[2] Naval procurement requests for FY-76 include funds for sixteen combatants and seven auxiliary craft. Current plans call for requests in FY-77 for funds to construct an additional twenty-five combatants and four auxiliaries.[3]

The Navy also spends large sums on conversion, alteration, and repair. Approximately 60 to 70 percent of these monies are spent in naval shipyards, which currently employ about 60,000 workers. With an increase in fleet size, demand on shipyard capacity for this type of work is expected to remain strong.

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[1]U.S. Congress, House, Committee on Armed Services, *Hearings on Military Posture and H.R. 3689 (H.R. 6674)*, Department of Defense Authorization For Appropriations for Fiscal Year 1976 and 1977, 94th Cong., 1st sess., 1975, Part 3, p. 3049.

[2]*Current Status of Shipyards*, *op. cit.*, Part 2, p. 1508.

[3]*Hearings on Military Posture*, *op. cit.*, Part 3, pp. 3037-69.

c. Summary

All aspects of the shipbuilding and repair industry are realizing demand increases following a period of decline.[1] The situation may be quite comparable to the price-quantity illustration in Figure 41; that is, firms have not yet been able to adjust to the new demand conditions. The existence of a shortage (i.e., demands exceeding currently available supplies as evidenced by unfilled job vacancies) should not be alarming. This shortage should be a normal situation; it is expected to exist in all but perfect labor markets and typically for all but the least-skilled workers.

The pressing issue is not whether a shortage exists, but rather its size, its anticipated duration, the actions that can be taken to minimize or eliminate it, and the cost of various remedial actions. In this regard, we turn to a closer examination of the industry's demands, wage position, and labor-supply conditions.

2. Manpower Demand Projections

a. Methodology

Manpower requirements for ship and non-ship activities in private shipyards have been forecast by the Office of Ship Production, NAVSEA, and are displayed in the next section.[2] Such projections are, by their very nature, imprecise, but they are still useful in showing probable trends in demand based on the assumptions upon which they were made. In the case of the NAVSEA projection, the estimates should be interpreted as an

[1] In most recent months the demand for tankers has declined. It is too early to determine whether this is caused by worldwide recession in the industrial countries or if this is evidence of a longer range phenomenon.

[2] Projected requirements are presented in the next section. This section addresses problems associated with the methodology used to develop the projections.

upper bound of manpower requirements or demand by the private shipyard industry. In this sense, they must be used with caution.

Requirements for the overhaul and repair of commercial vessels and for construction of oil rigs and barges and other non-ship work have been straight-lined, i.e., they have been assumed to remain at their 1974 levels throughout the projection period. All estimates are presented in terms of equivalent mandays. Leave, absenteeism, and overtime (normally 10 to 15 percent of total employment) have been excluded.[1] Thus, these estimates are of manpower requirements and not probable manning levels.

The requirements for construction activities are based on estimates of the time distribution of direct labor inputs over the building period for each ship, by shipyard. For ships planned, but not yet awarded, a most likely yard for each is determined. This selection is based primarily on the yard's facility limitations, such as the number and size of building positions and crane lift capacity, and on its institutional features, such as nuclear work capability and the frequency of naval repair and overhaul work and of non-ship work. In some instances, area manpower limitations are incorporated into the allocating scheme.

The projections are based upon a set of fixed input-output relations (i.e., a given number of manhours per ship type) so that factors such as changing (increasing or decreasing) levels of productivity, variations in the skill mix, and the possibility of even moderate changes in technology or productive techniques are not considered. If the anticipated level of orders materializes, some yards may find it advantageous to

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[1]"Equivalent men" is a NAVSEA estimate based on fixed input-output relationships for Navy ship construction by ship type with no allowance for leave time, absenteeism, or overtime.

subcontract some component work. If so, the increase in labor demands will not be restricted to the shipyards, but may be spread to other establishments and even to other labor markets.

There are, of course, reasons to believe that the anticipated workload will not materialize. If the current domestic and worldwide recession persists, ship construction demands will probably subside. Continuing rates of inflation will affect commercial ship construction demands and will have a serious influence on the Navy's procurement ability. Also, recent cancellations of oil tanker construction contracts point to a possibly over-optimistic interpretation of the energy market's influence on shipbuilding.[1]

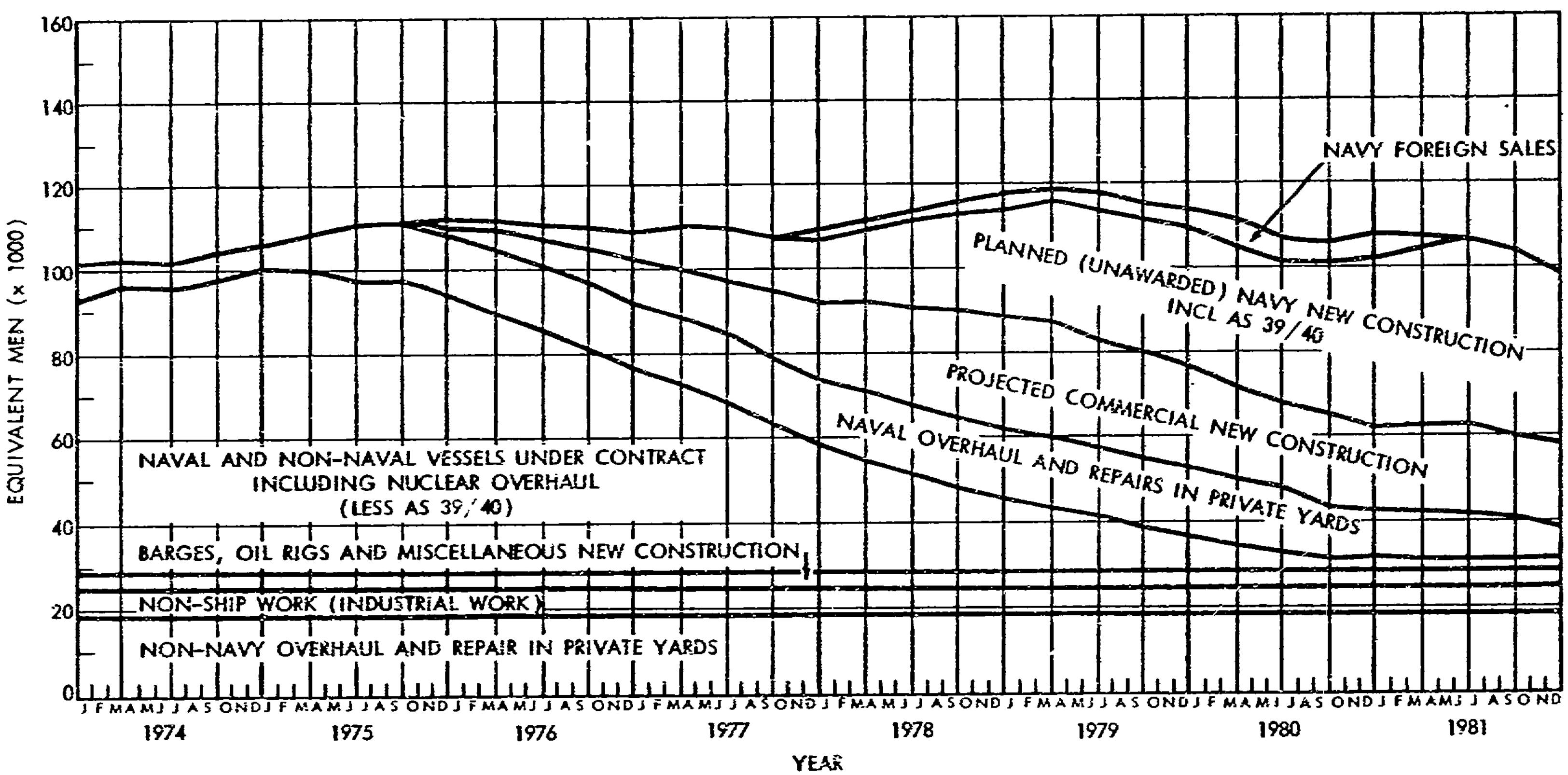
Despite the above limitations, the NAVSEA estimates provide a useful basis for evaluating future manpower requirements in private shipyard.

b. Demand Projections, 1975-1981

The NAVSEA projections for the private shipyards through 1981 are presented in Figure 45 and summarized in Table 43. Total manpower demands are estimated to rise to 111,000 mandays by the end of 1975, remain fairly constant through the middle of 1977, taper off a bit before rising to 118,500 mandays at the end of 1978, and peak slightly above this level about mid-1979. Based on these projections, an increase in employment of 5.2 percent is required in 1975, a monthly average of less than 0.5 percent.

The demand estimate for 1975 is the result of a projected increase of 8,000 equivalent men for Navy overhaul and repair and an equivalent-man decrease of 2,500 for construction from the 1974 figure. These figures may be misleading because non-nuclear overhaul is included with ship repair work, while

[1]Consider, for example, the cancellations of tanker orders at Seatrain Shipyard, Brooklyn, New York.



Source: Naval Sea Systems Command, Office of Ship Production, February 1975, Philadelphia, Pennsylvania.

Figure 45. SHIPBUILDING INDUSTRY WORKLOAD FORECAST FOR 1974 THROUGH 1981 (TOTAL DIRECT INCLUDING ENGINEERING) AS OF 10 FEBRUARY 1975

Table 43. MANPOWER DEMAND PROJECTIONS FOR PRIVATE SHIPYARDS, EQUIVALENT MEN, 1975-81*

Date	Naval Overhaul and Repair Excluding Submarine Overhaul		Activities Other Than Ship Construction	Total Other Than Ship Construction		Total Construction Including Submarine Overhaul		Total	
12/30/74	6,000	--	29,500	35,500	--	70,000	--	105,500	--
12/30/75	14,000	(133.3)	29,500	43,500	(22.5)	67,500	(-3.6)	111,000	(5.2)
12/30/76	16,000	(14.2)	29,500	45,500	(4.5)	65,500	(-3.0)	111,000	--
12/30/77	16,000	--	29,500	45,500	--	64,000	(-2.3)	109,500	(-1.[illegible])
12/30/78	16,500	(3.1)	29,500	46,000	(1.0)	72,500	(13.2)	118,500	(8.2)
12/30/79	16,500	--	29,500	46,000	--	68,000	(-6.3)	114,000	(-3.8)
12/30/80	10,000	(-39.4)	29,500	39,500	(-14.2)	66,500	(-2.3)	106,000	(-7.1)
12/30/81	8,000	(-20.0)	29,500	37,500	(-5.1)	61,000	(-8.3)	98,500	(-7.1)

*Figures in parentheses represent the percentage increase or decrease from the previous year.

Source: Naval Sea Systems Command, Office of Ship Production, February 1975, Philadelphia, Pennsylvania.

nuclear overhaul as part of a conversion is included with construction, e.g., the Polaris/Poseidon conversion program. This program, which accounts for 6,000 to 7,000 equivalent men, is in its final stages. By the end of calendar year 1977, as much as 70 percent of this manpower will be freed and much of it is likely to be assigned to other naval repair work.[1] Due to the accounting practices used, the result will be an increase in manpower assigned to naval repair and a decrease in construction. Consequently, the manpower demand for new construction will not decline, or at least not as rapidly as indicated by the figures in Table 43. With this feature in mind, the manpower demands for new construction will rise at best gradually in 1975 and 1976, as well as through 1979.

Of the large number of shipyards that constitute the shipbuilding and repair industry, only about 19 coastal area shipyards have the capabilities to build the larger vessels currently in demand. These major coastal yards and their capabilities are listed in Table 44. All coastal areas except the South Atlantic seaboard are represented. In addition, ships in excess of 900 feet cannot be built in any of the existing facilities in the Pacific Northwest. In general, the geographic distribution of building positions able to accommodate large ships is roughly the same as the distribution of all shipyards, and hence, the projected manpower buildup should have no specific regional aspect. Consequently, questions concerning the adequacy of labor supplies can be addressed, at least initially, in aggregate terms.

3. Wage Rates

Wage rates in the shipbuilding industry have been reported as being "generally comparative" with those in most industries,

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[1]Information on manpower utilized in the Polaris conversion program was provided by NAVSEA.

Table 44. BUILDING WAYS BY LENGTH (MAXIMUM SHIP SIZE), MAJOR U.S. SHIPYARDS; ATLANTIC, PACIFIC AND GULF COASTS

Shipyard & Coast	Length (in Feet)											
	475	550	600	700	800	900	1000	1100	1200	1300	1400	1600
ATLANTIC COAST												
Bath Iron Works	3	3	3	2	-	-	-	-	-	-	-	-
Bethlehem, Sparrows Point	7	7	6	3	3	3	1	1	1	-	-	-
General Dynamics, Quincy	5	5	5	5	5	1	-	-	-	-	-	-
Maryland SB & DD	1	1	1	-	-	-	-	-	-	-	-	-
Newport News SB & DD[1]	7	7	7	7	5	5	2	1	1	1	1	1
Seatrain SB Corporation	3	3	3	3	2	2	2	-	-	-	-	-
Sun SB & DD	6	6	6	6	2	1	1	1	1	1	1	1
Total	32	32	31	26	17	12	6	3	3	2	2	2
PACIFIC COAST												
Bethlehem, San Francisco	1	1	-	-	-	-	-	-	-	-	-	-
FMC Corporation	1	1	1	-	-	-	-	-	-	-	-	-
Lockheed SB	3	3	2	-	-	-	-	-	-	-	-	-
National Steel & SB	4	4	4	3	2	2	-	-	-	-	-	-
Todd, San Pedro	2	2	2	2	2	2	-	-	-	-	-	-
Todd, Seattle	1	1	-	-	-	-	-	-	-	-	-	-
Total	12	12	9	5	4	4	-	-	-	-	-	-
GULF COAST												
Alabama SB & DD	5	1	1	-	-	-	-	-	-	-	-	-
Avondale	8	8	8	3	3	3	3	3	3	-	-	-
Bethlehem, Beaumont	1	1	1	1	1	-	-	-	-	-	-	-
Ingalls[2]	13	13	11	6	6	6	6	-	-	-	-	-
Levingston SB Company	1	1	1	1	1	1	1	1	-	-	-	-
Marathon	1	1	1	1	1	1	1	1	1	1	1	-
Total	29	25	23	12	12	11	11	5	4	1	1	-
Total All Coasts	73	69	63	43	33	27	17	8	7	3	3	2

[1]The longest building way has been designed for commercial and not naval vessels. [2]Includes both east and west banks.

Source: U.S. Congress, House, Hearings before the Seapower Subcommittee of the Committee on Armed Forces, *Current Status of Shipyards--1974*, 93rd Cong., 2d sess., July-October 1974, Part 3, pp. 1228-29.

but somewhat lower than in the construction industry.[1] Data relating to nationwide averages of earnings in the yards and other industries are presented in Table 45. In general, these figures show a deteriorating relative wage position in the nation's shipyards.

On an hourly basis, wages in the ship and boat building and repair industry have continued to exceed the economy-wide average and even the average rate in the durable goods manufacturing sector; however, this advantage has deteriorated over time.[2] In 1961, wage rates in the yards were 64 cents (30 percent) above the average in the private non-agricultural sector and 29 cents (12 percent) above those in the durable goods producing sector. By 1973 these advantages had fallen to 44 cents (11 percent) for the non-agricultural sector and zero for the durable goods producing sector. At the same time, the disadvantage relative to construction increased from 42 cents (15 percent) in 1961 to $2.14 (49 percent) in 1973.

An analysis of weekly earnings tells much the same story. In 1961, weekly earnings in the nation's shipyards were well above the economy-wide average and those earned in the durable goods producing sector, while almost on a par with those in construction. Weekly earnings in the nation's shipyards are still above the economy-wide average but are below those in the durable goods sector and are now well below those in construction. Part of this is due to the relatively slow advance in hourly shipyard rates, but part is also due to a reduction in hours worked in the yards. The "normal" workweek for production

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[1] *Current Status of Shipyards, op. cit.*, Part 2, p. 642.

[2] This demand analysis compares wages in the ship and boat building and repair industry to wages in other industries that are grouped into highly aggregated categories. This approach is used to support the discussion of manpower shortages in general. As indicated earlier (see Chapter V and Appendix O), however, private shipyard wages are lower than wages for many of the jobs included in the wage surveys used to collect data to be used in determining the baseline wages for federal blue-collar employees.

Table 45. EARNINGS AND HOURS IN SELECTED INDUSTRIES, UNITED STATES, 1961-73 (Earnings in Current Dollars)

Calendar Year	Average Weekly Earnings				Average Hourly Earnings					Average Weekly Hours		
	Total Private Non-agriculture	Contract Construction	Durable Goods Manufacturing	Ship and Boat Building and Repair	Total Private Non-agriculture	Contract Construction	Durable Goods Manufacturing	Ship and Boat Building and Repair	Total Private Non-agriculture	Contract Construction	Durable Goods Manufacturing	Shipbuilding and Repair
1961	86.60	118.08	100.35	111.20	2.14	3.20	2.49	2.78	38.6	36.9	39.8	40.0
1962	85.91	122.47	104.70	115.26	2.22	3.31	2.56	2.86	38.7	37.0	40.4	40.4
1963	88.46	127.19	108.09	121.06	2.28	3.41	2.63	2.96	38.8	37.3	40.5	41.0
1964	91.33	132.06	112.19	121.10	2.36	3.55	2.71	2.99	38.7	37.2	40.7	40.7
1965	95.06	138.08	117.18	121.50	2.45	3.70	2.79	3.00	38.8	37.4	41.2	40.5
1966	98.82	146.26	122.09	130.41	2.56	3.89	2.90	3.15	38.6	37.6	41.3	41.5
1967	101.84	154.95	123.60	132.03	2.68	4.11	3.00	3.26	38.0	37.7	40.6	40.5
1968	107.73	164.93	132.07	137.23	2.85	4.41	3.19	3.38	37.8	37.4	40.7	40.5
1969	114.61	181.54	140.01	145.25	3.04	4.79	3.39	3.56	37.7	37.9	40.6	40.7
1970	119.46	195.98	143.47	150.07	3.22	5.24	3.56	3.78	37.1	37.4	39.8	39.9
1971	126.91	212.24	153.52	154.45	3.43	5.69	3.80	3.91	37.0	37.3	39.9	39.5
1972	135.78	224.22	167.27	161.65	3.65	6.06	4.05	4.07	37.2	37.0	40.6	39.7
1973	144.32	240.68	179.28	165.56	3.89	6.47	4.32	4.33	37.1	37.2	40.7	38.7
Average Annual Growth 1961-73	5.6	9.5	6.6	4.3	6.8	8.5	6.1	4.7	--	--	--	--

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings Statistics for the United States, 1909-70*, Bulletin 1312-7 and various issues of *Employment and Earnings*, Washington, D.C.

workers in manufacturing is usually considered to be 40 hours, yet the actual workweek in the yards has been below this level since 1970, and fell to 38.7 in 1973. This alone accounts for a reduction in weekly earnings of about $6.00 or 3.4 percent.

This overall wage-rate trend indicates that shipyards should be experiencing increased difficulty in attracting and retaining labor. In fact, the persistence of such a trend could lead to high turnover (quits) and shortages of qualified personnel even during periods when demand for shipyard work is not increasing.

4. Manpower Supplies

Assuming that the labor demands described above materialize, will a shortage evolve? The answer to this question depends both on management actions that would increase the number of hours worked by the current shipyard work force, and on management's ability to increase the total number of employees in shipyards.

a. Absenteeism and Average Weekly Hours

The use of equivalent workdays in NAVSEA's projections immediately suggests that reductions in absenteeism and an increase in hours worked represent ways to prevent a shortage. Based on the evidence presented in Table 45, increases in average weekly hours could conceivably make up a sizable portion of the total manpower demand increase.

Further analysis of the potential for manhour increases is hampered by a lack of data. Absenteeism rates are not regularly published. If absenteeism is a major problem, one would expect large amounts of overtime to be used. While the BLS publishes average weekly overtime hours for many industries, it does not publish those data for the shipbuilding and repair industry. The only relevant data available are on average weekly hours,

which represent hours paid and therefore include the effects of absenteeism and overtime.

It was reported in Table 45 that shipyard production workers averaged only 38.7 hours per week in 1973. The hours per week for more recent months are reported in Table 46. The trend, if there is one, is toward a further reduction in weekly hours. This is not consistent with normal behavior during periods of increasing workloads. In fact, given the general lack of alternative employment opportunities in today's economy, it is most surprising.

Because of the lack of sufficient data to determine the cause of this behavior of weekly hours, the increase in requirements for equivalent men projected in Table 46 will be treated below as an increase in employment requirements. This probably results in manpower demands being overestimated.

b. <u>Accessions and Separations</u>

Furtner increases in the work force must come from hiring. The past experience of the industry is reported in Table 47, which presents data on employment (actual not equivalents) and various gross labor flows. The employment data are annual averages and changes in those averages. The gross flows are monthly averages for each year.

Increases in employment require that firms enter the external labor market and hire new workers. New-hire rates vary directly with the change in employment. The marked increase in new-hire rates in 1964 immediately preceded two successive years of rapid employment growth. With each decrease in total employment, new-hire rates have slowed. Based on these rates, the shipyards have been able to attract large numbers of workers even during periods marked by low nationwide levels of unemployment. As shown in Table 47, the number of new-hires does not equate with changes in employment levels. In 1967, 1970, and

Table 46. AVERAGE WEEKLY HOURS, SHIPBUILDING AND REPAIR INDUSTRY, OCTOBER 1974-FEBRUARY 1975

Date	Average Weekly Hours (Not Seasonally Adjusted)
October 1974	37.9
November 1974	38.1
December 1974	39.5
January 1975	37.2
February 1975	37.2

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, January 1975 - April 1975.

1971, for instance, total shipyard employment fell while new hiring took place at rates of 4.6, 3.7, and 3.9 percent, respectively. To some extent, these rates reflect a problem of aggregation. Some yards were expanding while others (most) were cutting back. It is difficult to conceive, however, that this alone resulted in new-hire rates of the magnitude reported in those years. More likely, new hires also occurred to replace workers who quit, retired, or were discharged. With this replacement function of new hires in mind, note that in 1966 the average rate of new hires for 2.2 months accounted for the total annual increase in employment. In only three years since 1959 has the annual employment growth rate exceeded the average monthly new-hire rate (i.e., 1961, 1965, and 1966). From these data it is clear that a major problem facing the nation's shipyards is not in the hiring, but rather in the retention of workers, although both are primarily a function of wages.

One aspect of the retention problem is addressed in the comparison of layoff and rehire rates. It has been reported that repair yard employees are prone to frequent layoffs, but typically of short duration. For instance, a Mark Battle study

Table 47. EMPLOYMENT AND GROSS LABOR FLOWS, PRIVATE SHIPYARDS, 1950-1974

Calendar Year	Average Annual Employment (X000)	Annual Percentage Change in Employment	Monthly New Hire Rate	Monthly Layoff Rate	Monthly Rehire Rate	Monthly Quit Rate
1950	72.0	--	--	--	--	--
1955	101.0	--	--	--	--	--
1958	122.7	--	3.6	9.6	8.0	1.7
1959	117.5	-4.3	3.0	9.1	8.1	1.6
1960	111.8	-4.9	3.6	8.8	7.8	1.7
1961	116.0	3.7	3.3	8.6	7.2	1.6
1962	114.6	-1.3	3.2	7.9	7.1	1.6
1963	115.5	0.7	3.6	8.2	6.1	1.6
1964	116.8	1.1	4.8	7.7	6.7	1.8
1965	128.9	10.3	5.1	5.8	4.7	2.2
1966	143.6	11.4	5.0	4.8	3.9	2.9
1967	140.0	-2.5	4.6	5.4	4.0	2.4
1968	141.0	0.7	4.9	4.6	3.2	2.7
1969	142.0	0.7	5.0	3.7	3.3	3.0
1970	132.7	-6.5	3.7	4.6	3.6	2.2
1971	129.7	-2.2	3.9	5.3	5.3	2.0
1972	134.5	3.7	3.9	4.2	4.2	2.1
1973	138.3	2.8	4.8	3.3	3.1	2.7
1974 (1st quarter)	147.1	6.3	5.1	1.9	2.5	2.5
Average (1958-73)	--	--	--	6.4	5.4	2.3

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings Statistics for the United States, 1909-70*, Bulletin 1312-7 and various issues of *Employment and Earnings*, Washington, D. C.

reports layoff rates in repair yards in excess of 100 percent.[1] Given that these workers are continually exposed to the rigors of the job market, some may opt for alternative employment. If in fact some do find jobs elsewhere, they will not likely respond to a recall. A new hire is then necessary.

The probability of a worker being successfully recalled is some function of the rate of employment growth in the industry and that in the aggregate economy; 1965, 1966, 1968, and 1969 were years of a growing or fairly constant shipbuilding industry work force and of low aggregate unemployment. Private shipyard rehire rates in those years equaled 70 percent of layoff rates. In 1970-73, shipbuilding employment first fell and then rose, while the national economy was marked by recession. Rehire rates approached 100 percent of layoff rates. For the entire period, the ratio was 86 percent.

If the next several years are characterized by slower aggregate economic growth and persistent unemployment, that, in conjunction with increased labor demands in the shipyards, could reduce both layoff rates and the rate at which workers laid off from the shipyards seek work in other industries. The impact of this type of turnover on new-hire rates should substantially subside.

Quit rates in the nation's shipyards jumped beginning with 1965. In part, this was due to a falling aggregate unemployment rate and increased job opportunities elsewhere. Although these rates moderated somewhat with the 1969-70 recession, they did not fall to their pre-1965 levels. This may be the result of the weakened shipyard wage position. However, it should be noted that the phenomenon of "high" quits during this recession was not unique to this industry, but rather was typical of the economy-wide experience.

The sheer existence of quits requires firms to engage new hires if only to maintain a work force of given size. Howe·

[1]*Shipbuilding Manpower Study, op. cit.*, pp. 69-70.

quit rates tend to be highest among inexperienced and untrained workers, those groups most heavily represented in the new-hire category. Therefore, for every job vacancy--whether resulting from a quit or the desire to expand employment--more than one new hire will be necessary.

The generally weakened state of the aggregate economy should reduce quit rates in the industry to some extent. The growth in the industry should reduce layoff rates and in conjunction with high aggregate unemployment should reduce manpower losses due to non-recallability.

5. New-Hire Projections

To this point, the analysis has indicated that private shipyard employment demands are projected to increase by 5.2 percent in 1975 and remain fairly stable through 1976. Because of employment retention problems, new-hire rates in excess of this level will be required if projected employment levels are to be attained. The logical questions that arise at this point are what is the required rate of new hires and is it attainable?

An attempt was made to project the required new-hire rates. It is admittedly crude in that it ignores the potential problems related to skill-mix and various regional or local considerations. The technique employed is to identify a set of variables that reliably explain new-hire activitiy in the past and then using projected levels of these variables to predict new-hire requirements.

Since new hires occur in response to both increased employment needs and because of attrition would seem that projected percentage change in employment and quit rate could serve as two reliable predictors of new-hire rates. However, as discussed earlier, new-hire and quit rates are simultaneously determined. The level of earnings in the industry relative to those elsewhere and the aggregate level of job opportunities

are likely to be related to the industry quit rate but not simultaneously with the new-hire rate. Therefore, the following functional relation was posited:

NHR = F(% Δ E, RELWAGE, UNEMP)

where,

NHR = the industry new-hire rate, measured as an annual average of monthly rates;

% Δ E = the annual percentage change in industry employment,

RELWAGE = the ratio of average hourly earnings in the industry (SIC 3731) to that in all durable goods manufacturing industries; and

UNEMP = the annual aggregate U. S. unemployment rate.

Linear regression techniques were employed using data covering the period 1959-73. The final set of results are presented here, with "t" values given in parentheses. The earnings variable was not found to be significant and was dropped from the analysis.[1]

$$\underset{}{NHR} = \underset{(11.83)}{6.80} + \underset{(2.83)}{0.06\%\,\Delta E} - \underset{(-4.80)}{0.54\ UNEMP}$$

$$R^2 = 0.76$$

$$F = 19.53$$

$$df = 12.$$

All coefficients are significant at the .05 level.

As noted above, employment demand was projected by NAVSEA to increase 5.2 percent in 1975 and to remain stable in 1976.

[1]The critical values for significance at the .05 and .01 levels (12 degrees of freedom--df) are 2.179 and 3.055, respectively. The equation with the earnings variable was:

$$NHR = \underset{(3.60)}{11.02} + \underset{(2.93)}{0.06\%\,\Delta E} - \underset{(-4.69)}{0.52\ UNEMP} - \underset{(-1.40)}{3.83\ RELWAGE}.$$

This lack of statistical significance of earnings here should not be interpreted as indicating its contribution to explaining quit rates. See Section E, below.

At this writing, the aggregate national unemployment rate is about 9 percent. However, to err on the side of safety, a 7 percent unemployment rate was used as our projection. Combined, these lead to a projection of a monthly new-hire rate in 1975 of 3.3 percent, or an annual rate of approximately 40 percent. For 1976, the projections are 3.0 percent and 36 percent, respectively.

Based on past experiences, these rates are quite low. Although we may be unwilling to accept the exact rates as completely reliable, we will accept the more general implication that the required new-hire rates are well within the capability of the industry.

6. Conclusions

Based on the evidence presented above, the problem faced by the U.S. shipbuilding and repair industry is quite clear. Expanding employment by 5.2 percent in 1975 should not pose a major problem, especially during a period of sluggish aggregate national economic growth. The problem, if there is one, is simply that time--and judging from the size of the desired increase in employment, not a long period of time--is needed to adjust to the new level of demand.

While sufficient numbers of workers can be attracted to the firms in the industry, these firms' positions are aggravated by high rates of quits and possibly other forms of attrition. Policies aimed at reducing the quit rates of new hires and, especially, experienced workers should substantially reduce the need for new-hiring activity.

D. SHIPYARD LABOR MARKET CHARACTERISTICS: AN INTERINDUSTRY AND DISAGGREGATE VIEW

Given the size of the retention aspect of the shipyard manpower problem, a more detailed investigation into the

problem is warranted. In this section, several of the labor market characteristics of the shipbuilding and repair industry are discussed. The industry is treated in the aggregate as well as at disaggregate levels where regional and occupational aspects come into focus. The section provides a useful background for the econometric analysis of quit and discharge rates presented in Section E.

1. Skill Intensity and the Industrial Distribution of the Skilled Work Force

Data relating to the industrial and area distribution of skilled workers are available from the decennial census. The census provides data on employment by occupation for several detailed industries, but it does not do so for shipbuilding and repair (SIC 3731). Rather, information is given on employment in the transportation industry for establishments *not* engaged in the production of motor vehicles and equipment (SIC 371) or in aircraft and parts (SIC 372). This residual group, other transportation, includes not only shipbuilding and repair establishments, but also companies engaged in the construction and repair of boats and barges, railroad cars, motorcycles, bicycles, and mobile homes. Based on Bureau of Labor Statistics data, shipbuilding and repair accounts for more than 40 percent of the total employment and 57 percent of production worker employment in this other transportation group. Consequently, while these data can support assumptions regarding shipbuilding and repair industry characteristics, they do not provide conclusive evidence. Despite these inadequacies, these data are the best available and are, therefore, used here.

Information concerning industrial skill intensities is presented in Table 48. Skilled craftsmen constituted 13.9 percent of the total number of workers employed in the United States in 1970, and 43.2 percent of the employed blue collar

Table 48. SKILL INTENSITY, SELECTED INDUSTRIES,[1] 1970

	EMPLOYMENT				
	Total (10^3)	Total Blue Collar[2] (10^3)	Total Craft & Kindred Worker (10^3)	Craft as % of Total Employment	Craft as % of Blue Collar
Total Private	76,553.6	24,539.4	10,609.6	13.9	43.2
Contract Construction	4,572.2	3,388.4	2,559.7	56.0	75.5
Total Manufacturing	19,837.2	12,769.4	3,908.8	19.7	30.6
Durable	11,741.0	7,609.2	2,587.3	22.0	34.0
Non-Durable	8,096.2	5,160.2	1,321.5	16.3	25.6
Other Transportation	420.4	303.5	171.9	40.9	56.6

[1]Includes government employment.

[2]Blue collar workers include craft and kindred workers, operatives (except transportation), and laborers (except farm).

Source: U.S. Department of Commerce, Bureau of Census, *Census of Populations: 1970, U.S. Summary*, Table 232, "Occupation of Employed Persons by Industry Group and Sex: 1970," Washington, D.C.

workers. They represented 40.9 percent and 56.6 percent of total and blue collar employment, respectively, in the other transportation group.

The skill content of the work force in the other transportation group is also higher than that in all manufacturing and durable manufacturing industries, while somewhat below that in construction. The indication is that shipbuilding and repair is a skill-intensive industry. Another feature of the skill composition in the nation's shipyards is that 61 percent of the production workers employed in the major yards are journeymen.[1]

The distribution of the skilled blue collar work force in several of the major shipyard labor markets is shown in Table 49. Construction typically accounts for 20 to 30 percent of total area skilled blue collar employment. The major deviations seem to be in the fast-growing areas, such as Houston, Texas (34 percent), and in slow-growing areas, such as Jersey

[1]Derived from *Shipbuilding Manpower Study, op. cit.*, Appendix 6.

Table 49. DISTRIBUTION OF AREA CRAFT WORKER EMPLOYMENT, SELECTED INDUSTRIES, BY SMSA, 1970[1]

Labor Market	Craft Employment by Industry As Percentage of Area Total[2]		
	Construction	Manufacturing	Other Transportation
Boston, Massachusetts	26	35[3]	5[3]
New York, New York	25	29	1
Philadelphia, Pennsylvania	23	41	3
Jersey City, New Jersey	7	49	1
Baltimore, Maryland	25	61	5
Norfolk, Virginia	26	28	17
Newport News, Virginia	21	49	41
Charleston, South Carolina	26	40	22
Seattle/Everett, Washington	25	43	8
Portland, Oregon	24	35	4
San Francisco/Oakland, California	23	29[3]	4[3]
Los Angeles/Long Beach, California	20	39	2
San Diego, California	33	28	7
New Orleans, Louisiana	20	14	12
Houston, Texas	34	30	1
Beaumont, Texas	24	48	9

[1]Standard Metropolitan Statistical Areas (SMSAs) are 269 geographical areas making up the fifty states and Puerto Rico. These areas are defined by the U.S. Bureau of the Budget publication. Standard Metropolitan Statistical A[illegible]s. The general concept of an SMSA is an integrated economic and social unit with a large population nucleus.

[2]Includes government employment.

[3]Includes employment in naval shipyards that have since been closed.

Source: U.S. Department of Commerce, Bureau of Census, *Census of Population: 1970, Characteristics of the Population*, Table 180, "Occupations of Employed Persons by Industry Group and Sex: 1970, State Summaries," Washington, D. C.

City, New Jersey (7 percent). All manufacturing (including shipyards) typically accounts for another 25 to 50 percent. The exception here is New Orleans, which is dominated by service and other forms of light industry.

The importance of the shipyards in the area economies, as measured by their share of employment, varies widely. It ranges from as little as about 1 percent in New York, Houston, and Jersey City to 22 percent in Charleston and 41 percent in Newport News. Large labor markets, such as New York, Los Angeles-Long Beach, Houston, and Philadelphia, tend to have but a small portion of their skilled work forces employed in shipyards. The smaller areas, such as Charleston, Beaumont, Norfolk, and Newport News, tend to have much larger percentages. The notable exception here again is New Orleans.

The share of total area employment in the yards is an important factor in assessing the industry's ability to expand. Assume, for example, that each yard realizes an increase in demand such that it desires to expand its work force of skilled blue collar workers by 50 percent. Assume further that there is a "natural" increase in the number of skilled workers equal to 1.0 to 1.5 percent per year, the same rate that exists for the labor force nationwide. Under these hypothetical conditions, yards in, say, the Los Angeles-Long Beach area will seek an additional 3,300 skilled blue collar workers. This represents about 1 percent of the area work force. Some, and possibly a large part, of this increase can be met by the natural increase in the labor supply. If this does not provide sufficient additional manpower, more intense recruiting techniques can be undertaken or higher wage rates paid. Since the shipyards here are attempting to attract only an additional 1 percent of the total labor force, the impact is likely to be spread almost imperceptibly over many other industries. Even if higher wages are paid by the shipyards, it is not likely to result in retaliation by other industries.

In an area such as Newport News, a different situation emerges. Here the 50 percent increase in labor demands amounts to 3,400 workers, about the same as in Los Angeles-Long Beach; however in Newport News, this number is 20 percent of the area skilled blue-collar work force. The natural increase in the labor force will account for a maximum of one-tenth of the proposed increase. Even with intense recruiting in the area and moderate increases in wages, it is most unlikely that workers in sufficient numbers can be attracted to the yards. More vigorous efforts to increase employment, such as significant increases in wages, will most likely result in retaliation from other industries since shipyard employment already comprises a large share of total area blue-collar employment.

This discussion emphasizes that the ability of the shipbuilding and repair industry to expand will vary by region. The ease with which expansion can occur is probably inversely related to the industry's share of total area employment. In areas where shipyard employment is but a small percentage of the total in the area, actions like moderate wage increases can result in immediate and significant increases in labor supplies. In technical economic terms, the supply curve of shipyard labor in these markets is highly price elastic. In areas such as Charleston, Norfolk, or Newport News, attempts to increase employment by wage increases are likely to result in little increase in shipyard employment. The labor supply for the shipyards there is price inelastic. Expansion of shipyard employment in these areas may be more effectively pursued by policies designed to increase the total labor supply in the area, rather than increasing only the shipyard's share.

2. Shipyard and Area Wage Rates

It was reported above that hourly and weekly wage rates in the shipbuilding industry have fallen relative to those in

other industries. A more detailed examination of this phenomenon is presented here.

a. Wage Rates in Private Shipyards

Table 50 presents private shipyard wage rate data for five major journeymen occupations as obtained from respective BLS collective bargaining agreement files. To provide additional perspective, the data are presented by region. In each case, the wage rate presented is that for the highest paying yard in the region. Two points can be noted from these data:

(1) Wage rates in the yards vary across regions. They are lowest in the Southeast and highest in the Southwest and San Diego. Shipyard wages are generally higher on the West Coast than on the East Coast.

(2) Regardless of any skill differences, interoccupational wage differences within each yard are nonexistent.

b. Private Versus Naval Shipyards

Table 51 provides a comparison of journeyman wages in naval and private yards with wages paid in the contract construction industry and in an aggregated non-construction industry category. Data for the private yards are the same as in Table 50. In the naval yards, most journeyman mechanics are classified as Wage Board (WG-10) employees. As in the private sector, there are no interoccupational wage differences in the naval yards. The wage rate used here is for step 3, 4 percent higher than the benchmark rate.[1] Data for area construction

[1] WG-10, step 3 wage rates were selected as the reasonable level to compare to average hourly earnings of journeymen in the local labor market. In December 1973, the majority of naval shipyard employees were at step 4. As a result use of step 3 may introduce some distortion into the ratios in Table 51 since the average pay for naval shipyard journeymen might be somewhat higher. The difference is not enough, however, to alter the relationships displayed in the table.

Table 50. HOURLY WAGE RATES OF SELECTED JOURNEYMAN OCCUPATIONS IN PRIVATE SHIPYARDS, BY REGION, 1973

Region*	Occupation				
	Shipfitter	Welder	Electrician	Sheet Metal Worker	Pipefitter
NEW ENGLAND (Groton, Connecticut)	4.58	4.58	4.58	4.58	4.58
MID ATLANTIC (Philadelphia, Pennsylvania)	4.71	4.71	4.71	4.71	4.71
BORDER (Norfolk, Virginia)	4.71	4.71	4.71	4.71	4.71
SOUTHEAST (Jacksonville, Florida)	4.40	4.40	4.40	4.40	4.40
SOUTHWEST (New Orleans, Louisiana)	5.45	5.45	5.45	5.45	5.55
PACIFIC NORTHWEST (Seattle, Washington)	5.09	5.09	5.09	5.09	5.09
SAN FRANCISCO	5.09	5.09	5.09	5.09	5.09
LOS ANGELES/LONG BEACH	5.14	5.14	5.14	5.14	5.14
SAN DIEGO	5.76	5.76	5.76	5.76	5.76

*The regions referred to here include: New England - Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; Mid Atlantic - New Jersey, New York and Pennsylvania; Border - Delaware, District of Columbia, Maryland and Virginia; Southeast - Alabama, Florida, Georgia, Mississippi, North Carolina and South Carolina; Southwest - Louisiana and Texas; Pacific Northwest - Alaska, Oregon and Washington; San Francisco, Los Angeles/Long Beach and San Diego refer to the cities.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Collective Bargaining Agreement Files, Washington, D.C.

Table 51. COMPARISON OF HOURLY EARNINGS OF JOURNEYMEN BY REGION, 1973

(Private and Naval Shipyards, Contract Construction, and Non-Construction Industries)

Region[1]	Hourly Earnings				Ratio of Wages in Private Shipyards to those in			Ratio of Wages in Naval Shipyards to those in	
	Private Shipyard[2]	Naval Shipyard	Contract Construction	Non-Construction	Naval Shipyard	Contract Construction	Non-Construction	Contract Construction	Non-Construction
NEW ENGLAND	4.58	5.01	8.24[3]	4.74[3]	.914	.556	.966	.608	1.057
Private - Electric Boat, Groton Naval - Portsmouth									
MID ATLANTIC	4.71	5.41	8.41	4.86	.871	.560	.969	.643	1.113
Private - Sun, Philadelphia Naval - Philadelphia									
BORDER	4.71	4.85	5.87	4.73	.971	.802	.996	.826	1.025
Private - Newport News Naval - Norfolk									
SOUTHEAST	4.40	5.22	6.43	4.55	.844	.684	.967	.812	1.147
Private - Jacksonville Naval - Charleston									
SOUTHWEST	5.55	--	6.72	4.72	--	.826	1.176	--	--
Private - Boland Marine, New Orleans Naval - None									
PACIFIC NORTHWEST	5.09	5.63	7.21	5.39	.904	.706	.944	.781	1.045
Private - Todd, Seattle Naval - Puget Sound									
SAN FRANCISCO	5.09	6.04	7.78	5.85	.843	.654	.870	.776	1.032
Private - Bethlehem Steel Naval - Mare Island									
LOS ANGELES/LONG BEACH	5.14	5.72	7.67	5.27	.899	.670	.975	.746	1.085
Private - Todd, San Pedro Naval - Long Beach									
SAN DIEGO	5.76	--	7.83	5.35	--	.736	1.077	--	--
Private - National Steel Naval - None									

[1] For definitions of regions see Table 50.

[2] Wage rates for highest paying private shipyard in region.

[3] Wage rate for Boston, Massachusetts.

Source: For private shipyard data see Table 50; for naval shipyard data see Table O-6, Appendix O--benchmark rates increased by four percent to reflect wage rate for WG-10, step 3; for contract construction data--U.S. Department of Labor, Bureau of Labor Statistics, *Union Wages and Hours: Building Trades*, Bulletin 1841, 1975, Table 17, "Average Wage Rates and Employer Contribution to Funds, Journeymen and Laborers: Selected Cities by Region," Washington, D.C.; for non-construction data--U.S. Department of Labor, Bureau of Labor Statistics, *Area Wage Surveys, Selected Metropolitan Areas 1972-73*, Bulletin 1775-97, October 1974, Table A-8 "Plant Occupations-All Industries," Washington, D.C.

and non-construction wages are from the BLS. Unless noted otherwise, these data refer to the average hourly earnings of all journeymen in the labor market area of the private yard. For instance, the data for the Mid-Atlantic states are actually those from the Philadelphia area.

Wage rates in the naval yards exceed those in the private yards in each region. This is a phenomenon built into the Federal employee wage-determining process as discussed in Chapter V.[1] Both the naval and the private yards are unionized, and quite often the workers are represented by the same union even though naval yard wages are not determined by collective bargaining.

Naval shipyards rates are highest in San Francisco and lowest in Norfolk. The ratio of private to naval shipyard wages is highest in the Norfolk area and lowest in the San Francisco area. While rates in the private yards are typically below those in other non-construction industries, the wage rates in the naval yards tend to be slightly above the rates in these industries.

c. Private Yards Versus Construction

While journeymen wage rates in all non-construction activities, including the shipyards, are higher on the West than on the East Coast, the opposite is true of construction wages. As a result, relative to construction, wages in the shipyards are lowest in New England and the Mid-Atlantic states and highest in the Border and southeastern states.

This comparison fails to account for the highly seasonal nature of employment in the construction industry. Table 52 addresses this deficiency by displaying the number of weeks

[1]See Section B.3 in Chapter V and Appendix O.

that must be worked by construction workers to receive the annual earnings of a journeyman employed full time in a private shipyard.

A journeyman in the Northeast need be assured of only 30 weeks work in construction to receive total annual pay equal to his possible full-time annual earnings in the private shipyards. The weeks required to equalize earnings are higher in the warmer climates. Assurances of 35 to 39 week are needed in the Southeast and on the West Coast, and of 44 weeks in the Southwest. The Border State figure (43.4) seems to be an anomaly.

These figures must be used with care for they (1) do not consider the possibility of overtime in either industry, (2) are based on the incorrect presumption of 50 weeks work being

Table 52. WEEKS WORKED IN CONSTRUCTION NECESSARY TO PROVIDE FULL-TIME SHIPYARD ANNUAL INCOME, BY REGION, 1973

Region*	Requirement in Weeks Worked
New England	30.1
Mid Atlantic	30.3
Border States	43.4
Southeast	37.0
Southwest	44.7
Pacific Northwest	38.2
San Francisco	35.4
Los Angeles/Long Beach	36.2
San Diego	39.8

*For definition of regions see Table 50.

Source: See Table 51.

assured in the yards, and (3) ignore the possibilities of odd jobs being available to construction workers and the income from unemployment compensation. Given these caveats, the figures tend to support the contention that hourly earnings in construction are above those in other industries because of the seasonability of the industry, and that these earnings differences vary with the intensity of seasonal fluctuations.

3. Separation Rates

In this section, interindustry differences in separation rates are addressed first. Attention is then turned to a disaggregate discussion of separations, quits, and discharges in the shipbuilding and repair industry.

a. Interindustry Comparisons

Quit Rates. Table 53 presents data on quits and other separations for the shipbuilding and repair industry and several other industries.

It is generally accepted that because they are highly trained, skilled workers are harder and more costly to replace. Employers will endeavor to assure the attachment of these workers to the firm by such actions as offering higher wages, more favorable working conditions, or more lucrative pension programs. The result is that lower quit rates are to be expected in the skill-intensive industries.

From Table 53, it can be seen that quit rates in the more skill-intensive durable goods manufacturing sector have been consistently below those in the less skill-intensive, non-durable goods producing sector. Since 1960, quit rates in these sectors averaged 1.7 percent and 2.3 percent, respectively.

Evidence presented earlier testifies to the high skill intensity of the shipbuilding and repair industry. Nevertheless,

Table 53. RATES OF QUITS AND OF OTHER SEPARATIONS, SELECTED INDUSTRIES, 1960-73

(Rates Per 100 Employees Per Month)

Calendar Year	Quit Rates						Rates of Other Separations					
	All Manufacturing Industries	Durable Manufacturers	Non-Durable Manufacturers	Fabricated Metal Products	Transportation Equipment	Shipbuilding and Repair	All Manufacturing Industries	Durable Manufacturers	Non-Durable Manufacturers	Fabricated Metal Products	Transportation Equipment	Shipbuilding and Repair
1960	1.3	1.1	1.6	1.1	0.9	1.7	0.6	0.7	0.6	0.7	0.7	0.7
1961	1.2	1.0	1.5	1.0	0.8	1.6	0.6	0.7	0.5	0.7	0.6	0.6
1962	1.4	1.2	1.7	1.3	1.0	1.6	0.7	0.7	0.6	0.7	0.8	0.7
1963	1.4	1.2	1.6	1.3	0.9	1.6	0.7	0.7	0.7	0.7	0.8	0.8
1964	1.5	1.3	1.7	1.5	1.0	1.8	0.7	0.8	0.7	0.8	0.8	0.7
1965	1.9	1.7	2.1	1.9	1.3	2.2	0.8	0.9	0.7	0.5	0.8	1.0
1966	2.6	2.4	2.8	2.8	1.9	2.9	0.8	1.0	0.8	1.1	0.8	1.2
1967	2.3	2.1	2.7	2.5	1.7	2.4	0.9	0.9	0.8	1.0	0.8	1.1
1968	2.5	2.2	2.8	2.8	1.8	2.7	0.9	1.1	0.8	1.0	0.9	1.3
1969	2.7	2.5	3.1	3.1	1.9	3.0	1.0	1.0	0.8	1.1	1.0	1.3
1970	2.1	1.8	2.6	2.1	1.3	2.2	0.9	0.9	0.8	1.7	0.9	1.3
1971	1.8	1.5	2.2	1.6	1.1	2.0	0.8	0.8	0.8	0.9	0.9	1.3
1972	2.2	1.9	2.7	2.1	1.4	2.1	0.9	0.8	0.8	1.0	0.9	1.5
1973	2.7	2.4	3.3	2.8	1.8	2.7	1.0	1.0	0.8	1.2	1.0	1.5
Average (1960-73)	2.0	1.7	2.3	2.0	1.3	2.2	--	--	--	--	--	--
Standard Deviation	.54	.53	.62	.71	.41	.49	--	--	--	--	--	--
Coef. Of Variation	.28	.30	.27	.36	.30	.22	--	--	--	--	--	--
Average 1960-64	1.4	1.2	1.6	1.2	0.9	1.7	--	--	--	--	--	--
Average 1965-69	2.2	2.2	2.7	2.6	1.7	2.6	--	--	--	--	--	--
Average 1970-72	2.0	1.7	2.5	1.9	1.3	2.1	--	--	--	--	--	--
Average (1965-69,73) / Average (1960-64,70-72)	1.4	1.5	1.4	1.7	1.6	1.4	--	--	--	--	--	--

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings Statistics for the United States, 1909-70*, Bulletin 1312-7 and various issues of *Employment and Earnings*, Washington, D.C.

the quit rate here has averaged 2.2 percent, a full 25 percent above the average in the durable goods producing sector. Rates for other industries that are both skill intensive and often described as active competitors for shipyard manpower are also presented in the table. Quit rates seem to be a less serious problem here, in that they are consistently below those experienced in the shipyards.

Another aspect of quit rates that may shed some light on shipyard manpower problems is the variance in the rates. Presumably workers quit to take advantage of better (e.g., higher paying) jobs elsewhere. These jobs are more readily available during periods of high economic activity. Quits have a cyclical relation; they rise as the level of unemployment falls. As seen in Table 53, during the years 1965 to 1969 and again in 1973, periods of relatively high or full employment, the quit rate in each industry was above its fourteen-year average.

The cyclical sensitivity of quits seems to vary across industries, and is least in the shipyards. During the six high-employment years, the quit rate in all durable goods manufacturing industries was 54 percent above the average for the other eight years. For fabricated metal products and transportation, the increase was 68 percent and 57 percent, respectively, while only 41 percent in the shipyards.

The coefficient of variation of quit rates by industry was also computed. (This statistic measures the dispersion about the mean and is equal to the standard deviation divided by the mean.) Over this time period, 1960-73, the coefficient for the shipbuilding and repair industry was smaller than that for any durable goods producing industry or even that of the non-durable goods producing sector. The indication is that over this period, which covers almost two full business cycles, the shipbuilding and repair industry quit rate was less responsive to changes in aggregate economic conditions.

As reported earlier, the wage rates in the yards are below those of other industries. This may account for the fact that during periods of sluggish economic activity, quit rates in the shipyard industry fall slower than those in other industries. The relation between quit rates and relative shipyard earnings is examined in greater detail below.

Rates of Other Separations. In addition to quits, separations due to discharges and retirements are also of interest. The Bureau of Labor Statistics does not publish data on these individual types of separations, only for total separations, quits and layoffs. Subtracting quits and layoffs from the total gives other separations, which includes discharges, retirements, and employment terminations resulting from death, disability, interplant transfers, and entrance into the armed forces. The rate of these other separations was presented in Table 53.

The rate of other separations in the shipyards in the early 1960s was quite similar to that in other industries. Beginning with 1965 and with the exception of 1967, there has been a steady and uninterrupted increase in this rate in the shipyards. This trend coincides with two phenomena. The first is the deterioration of the shipyard's wage position. This conceivably has led the yards to reduce hiring standards and allow on-the-job performance to serve as a screening device. The result may be a higher discharge rate.

The second phenomenon is the effect of the age of the shipyard work force. Large employment increases took place in the yards during World War II, and hence, large portions of the shipyard work force may now be reaching retirement age. Data relating to the prospects of retirement in the naval yards are presented in Table 54. Though similar data are not available for the private sector, Table 55 presents a comparison of some features of the age distribution of workers in the shipyards

Table 54. NUMBER (PERCENT) WL AND WG PERSONNEL GRADES 9-15 (JOURNEYMEN) EMPLOYED IN NAVAL SHIPYARDS ELIGIBLE FOR RETIREMENT AND NEAR ELIGIBLES, DECEMBER 1974

Shipyards	Current Eligible for Retirement				
	At Least 65 Years of Age and At Least 5 Years Service	At Least 60 Years of Age and At Least 20 Years Service	At Least 55 Years of Age and At Least 30 Years Service	Total Eligible Retirement	Total Near Eligibles*
Portsmouth	50 (2.0)	121 (4.8)	97 (3.8)	205 (8.1)	601 (23.8)
Philadelphia	88 (2.6)	195 (5.8)	212 (6.3)	367 (11.0)	789 (20.1)
Norfolk	93 (2.0)	283 (6.2)	340 (7.4)	524 (11.4)	858 (18.7)
Charleston	45 (1.5)	190 (6.5)	272 (9.3)	354 (12.1)	496 (16.9)
Mare Island	54 (1.5)	185 (4.8)	211 (5.5)	342 (8.9)	673 (17.5)
Puget Sound	35 (0.9)	131 (3.1)	84 (2.0)	280 (6.6)	466 (11.0)
Long Beach	77 (2.1)	177 (5.0)	147 (4.2)	307 (8.7)	536 (15.2)
Totals	*442 (1.8)*	*1,282 (5.1)*	*1,363 (5.4)*	*2,379 (9.5)*	*4,419 (17.7)*

*Eligible within the next five years.

Source: Department of the Navy, Office of Civilian Manpower Management, Rosslyn, Virginia.

Table 55. EMPLOYED MALES - AGES 55 YEARS AND ABOVE, SELECTED INDUSTRIES, 1970

Industry	Total (10^3)	Ages 55-59		Ages 60 and Above		Median Age
		Number (10^3)	Percent	Number (10^3)	Percent	
Total Private Economy	47623.8	4022.7	8.4	4854.6	10.2	40.2
Contract Construction	4305.0	363.1	8.4	410.1	9.5	40.8
All Manufacturing	14173.5	1230.5	8.7	1075.1	7.6	39.8
Durable Manufacturing	9248.1	800.4	8.6	661.6	7.2	39.9
Other Transportation	378.3	34.7	9.2	27.0	7.1	39.6
Fabricated Metal Products	962.2	84.9	8.8	74.6	7.8	40.1
Non-Durable Manufacturing	4836.8	422.6	8.7	405.3	8.4	39.5

Source: U.S Department of Commerce, Bureau of Census, *Census of Populations: 1970*, Vol 1, *Characteristics of the Population, U.S. Summary*, Table 239, "Age of Employed Persons by Industry by Sex: 1970," Washington, D.C.

("Other Transportation"--Table 55) and in other industries. These data indicate that retirement is having a stronger impact on planning in the naval than in the private shipyards.

b. Intra-industry Comparisons

Table 56 presents data, by region, on turnover rates in private yards. Turnover rates were lowest in the New England and San Francisco areas. This may be due to the recent closing of naval yards in those areas. The low rate in the Pacific Northwest is surprising in view of the current employment opportunities in Alaska. The Southeast and the Los Angeles/Long Beach areas realized the highest turnover rates, each more than 50 percent above the industry-wide average.

For all commercial yards, shipfitters had the highest turnover rates, followed by boilermakers and welders. Inter-area variances by occupation were found to be quite pronounced. However, occupations with above average industry-wide turnover rates tended to be above average in each region. Shipfitters, for instance, had a 27 percent turnover rate in the New England area, whereas the regional average was 22 percent. In the Los Angeles/Long Beach area, with a regional average of 64 percent, shipfitters averaged 89 percent.

Table 57 presents a similar analysis for naval shipyards. A regional pattern exists among the naval yards that is quite similar to that in the commercial shipyards. Turnover rates were highest in both commercial and naval shipyards in the Southeast and Los Angeles/Long Beach areas and lowest in New England.

4. Collective Bargaining Structure

No labor market analysis would be complete without a discussion of the collective bargaining framework and an investigation of its impact. Like most industries in the durable

Table 56. ANNUAL TURNOVER (QUIT PLUS DISCHARGE) RATES IN PRIVATE SHIPYARDS, BY REGION AND OCCUPATION, JULY 1972 - JUNE 1973

Occupation	Region[1]								
	New England	Mid-Atlantic	Border States	Southeast	Pacific Northwest	San Francisco	Los Angeles/Long Beach	San Diego	All Regions
Shipfitter	27	81	78	58	44	22	89	47	64
Welder	30	54	65	38	43	32	97	35	53
Machinist	16	18	42	73	18	32	40	40	34
Electrician	20	25	24	29	25	11	19	39	24
Sheetmetal worker	16	3	14	56	26	25	17	45	17
Pipefitter	23	11	52	73	26	29	74	27	40
Electronics mechanic	19	[2]	[2]	[2]	[2]	40	[2]	[2]	19
Loftsman	8	14	1	--	6	--	--	42	10
Rigger	17	27	10	98	47	34	41	39	24
Boilermaker	--	4	28	185	[2]	74	19	151	58
All Occupations	22	44	46	67	36	30	64	41	42

[1]For definitions of regions see Table 50. [2]No employment.

Source: Derived from Mark Battle Associates, *Shipbuilding Manpower Study, Appendices*, Volume 3, Appendices 11, 12, and 14, March 1974, Washington, D.C.

Table 57. ANNUAL TURNOVER (QUIT PLUS DISCHARGE) RATES IN NAVAL SHIPYARDS, BY SHIPYARD AND OCCUPATION, JULY 1972 - JUNE 1973

Occupation	Shipyard							
	Portsmouth	Philadelphia	Norfolk	Charleston	Puget Sound	San Francisco*	Long Beach	All Yards
Shipfitter	9	3		23	3	8	15	6
Welder	--	7	7	18	7	7	11	7
Machinist	2	8	8	10	8	7	11	7
Electrician	10	6	6	17	6	9	14	8
Sheetmetal Worker	4	3	3	14	3	2	12	8
Pipefitter	4	5	5	9	5	9	15	6
Electronics Mechanic	3	4	4	9	4	4	14	5
Loftsman	--	--	--	--	--	8	10	3
Rigger	3	4	4	10	4	5	25	7
Boilermaker	--	6	6	28	6	3	13	7
All Occupations	4	6	6	13	6	7	14	7

*Includes Hunter's Point.

Source: See Table 56.

goods producing sector, the shipbuilding and repair industry is heavily unionized. The structure of union organization in the industry is diverse, however, and may affect individual yards differently. A general description of the major forms of union organization is presented below to highlight differences in structure and impact. The classification of unions is based only on organizational structure and is intended merely to distinguish features relevant to the subsequent discussions.

The analysis then turns to a description of unions as they relate to the shipbuilding and repair industry labor market.

a. General Description

Unions can be organized primarily on an industrial or a craft basis. Industrial unions are organized along product-market lines. All non-supervisory production workers, regardless of skill, are eligible for membership and are typically represented. Craft unions include workers in the same occupation or skill, or group of related skills. The craft may be confined to one industry (e.g., truck drivers) or may be spread across many (e.g., machinists). Most craft unions are organizations of highly skilled workers. However, in those industries in which craft organization exists, the unskilled workers also tend to organize in what, in effect, is a craft union (e.g., common labor in construction).

A major difference in philosophy between the two types of unions concerns intraplant occupational mobility. This type of mobility is typically allowed, and at times promoted, by industrial unions. Craft unions are typically reluctant to allow members of other unions to do work traditionally assigned to their members. This philosophical difference is reflected in promotion, hiring, and layoff policies.

Industrial unions place a great deal of importance on "promotion from within." Employers are typically required to post notice of all existing job vacancies, and present employees have the opportunity to apply. A new hire can occur to fill a vacancy only if no qualified present employee is available. As a result, a continual upgrading of personnel takes place and often requires the crossing of occupational lines. Hiring efforts tend to be concentrated at the semi-skilled and unskilled levels.

In both industrial and craft unions, seniority plays a crucial role when layoffs occur. However, the scope of the

"seniority district" differs. Industrial unions favor the broadest seniority units, such as plant wide. Here, length of service is measured by time in the plant, regardless of time in any skill, department, or occupation. Craft unions, being concerned with individual occupational groups, usually concentrate on occupational or job-shop units. When layoffs occur in a firm in which a plant-wide seniority district exists, the least senior employee in the plant is the first laid off. This results in "bumping," i.e., more senior, and typically more skilled, workers are temporarily transferred (with no cut in wage) to less skilled job roles. Even though only temporary, this type of occupational mobility rarely occurs in the craft-union structure.

Skilled workers employed by firms organized on an industrial-union basis do not face the rigors of the job market with the frequency of those in craft unions. Firms organized by a craft union tend to hire or layoff skilled workers more often. In fact, the craft-union office often serves the function of an employment agency, the "hiring hall." In this manner, craft-union members can be made constantly aware of job opportunities, wages, and working conditions in the different firms and industries in the area. No counterpart to the hiring hall exists in the industrial union.

Because industrial unions stress promotion from within, the upgrading of employees is a continual process. In times of (moderate) increases in demand, the number of workers performing skill functions can be increased with relative ease. The increase in demand will be felt in the entry-level positions, i.e., at the semi-skilled level, and no intense competition need occur in the external skilled labor market. To be sure, craft unions also engage in training, but usually through a formal apprenticeship program. Often there are restrictions on the number of apprentices, usually in the form of their numbers relative to the number of journeymen. Consequently,

the number of apprentices can be increased only concurrently with an increase in the number of journeymen. If there is a shortage of journeymen, a serious bottleneck can develop.

b. Union Organization in the Shipyards

Figure 46 lists the types of unions representing workers in several of the major private shipyards and the naval yards. It is obvious that organization is of no one particular form. There are industrial, as well as craft, unions; craft unions negotiating independently, as well as in trade councils; independent unions, as well as those affiliated with the AFL-CIO. Industrial unions have organized primarily, though not exclusively, the yards in the North and East and in the Los Angeles area. The Industrial Union of Marine and Shipbuilders Workers of America represents the workers in most of these yards. A master agreement exists between this union and all Bethlehem Steel's East Coast facilities (Boston, Hoboken, Sparrows Point, and Key Highway). There is a master agreement at Bath, General Dynamics (Quincy), and Maryland Dry Dock. The workers at the Todd facilities in New York, New Orleans, and Los Angeles are organized by this union, but not those in Galveston, Houston, or Seattle. The nation's largest yard, Newport News, and the Electric Boat Groton facility also have industrial unions. These, however, are independents, i.e., not affiliated with the AFL-CIO.

The Metal Trades Council is the organization of craft unions in the yards and negotiates with many yards on an individual basis. This trade council has one major master agreement with about 160 establishments (yards and shops) on the West Coast, extending as far south as San Francisco. Though there is a master agreement providing for uniform practices in all covered yards, there is no formal employers association.

Shipyard or Group	Collective Bargaining Agent
Bath Iron Works	International Union of Marine and Shipbuilders Workers of America (AFL-CIO)
General Dynamics, Quincy	International Union of Marine and Shipbuilders Workers of America (AFL-CIO)
Maryland Shipbuilding and Drydock	International Union of Marine and Shipbuilders Workers of America (AFL-CIO)
Bethlehem Steel Corporation; Boston, Sparrows Point, Key Highway, San Pedro	International Union of Marine and Shipbuilders Workers of America (AFL-CIO)
Todd Shipyard Corporation; Brooklyn, New Orleans, Galveston, San Pedro	International Union of Marine and Shipbuilders Workers of America (AFL-CIO)
Bethlehem Steel Corporation, Beaumont	Metal Trades Council (AFL-CIO)
Todd Shipyard Corporation, Houston	Metal Trades Council (AFL-CIO)
Litton Industries, Ingalls Shipyards, Pascagoula	Metal Trades Council (AFL-CIO)
All U.S. Naval Shipyards	Metal Trades Council (AFL-CIO)
All private shipyards on West Coast, San Francisco and north	Metal Trades Council (AFL-CIO)
Sun Shipbuilding	Boilermakers[1] (AFL-CIO)
Jacksonville Shipyards	Boilermakers[1] (AFL-CIO)
Norfolk Shipbuilding and Drydock	Boilermakers[1] (AFL-CIO)
Newport News Shipbuilding and Drydock	Peninsula Shipbuilders Association[2]

[1]Though the Boilermaker's Union is usually viewed as a craft union, organization here is on an industrial basis.

[2]Not affiliated with the AFL-CIO.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Collective Bargaining Agreement Files, Washington, D.C.

Figure 46. COLLECTIVE BARGAINING AGENTS IN MAJOR SHIPYARDS

5. Training

Training programs in the shipyards deal with entry-level training, labor upgrade, and apprentice instruction. Of these, only formal apprenticeship programs generally lead to full journeyman status. The upgrade programs tend to concentrate on enabling semi-skilled workers to function as helpers or even perform some of the basic skills during periods of peak production.

a. Training in the Private Sector

In-House Training Programs. Not all yards have continual in-house training programs. Of the forty-seven private yards surveyed by the Mark Battle Associates, only twelve reported having a formal apprentice program. With the exception of the Bath, Electric Boat, and Newport News shipyards, these programs were limited to only a few specialized occupations or had only a small number of participants. Only twenty-two yards reported having any type of formal in-house training program. Most of these programs were fairly short-term intensive programs, ranging up to sixteen weeks, and were generally labor upgrade programs providing the basic welding and shipfitting skills. The total output of all of the training programs in private shipyards is not adequate to meet significant expansion in the industry without encountering skill shortages at least regionally.[1]

The lack of formal in-house training programs in the private yards is likely to be the result of two possibly related factors. The first factor is the high attrition rate among shipyard workers, especially among new employees. This prohibits

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[1] *Shipbuilding Manpower Study, op. cit.*, pp. 86-89 and 136. Even though the apprentice programs at the three very important shipyards listed are larger than in the other shipyards, their output is not large enough to prevent skill shortages if current workloads are increased significantly.

the yards from earning a productive return on their training investment. Second, the large variance in workload experienced by many yards necessitates continual hiring and layoffs. Yards in this category, most of which tend to be repair oriented, find it less expensive to simply hire workers as needed.

The impact of training programs on shipyard employment is addressed in Table 58. The data pertain to 47 private and naval yards located along the Atlantic and Pacific Coasts and are based upon a Mark Battle Associates survey. It must be noted that these are the outputs from all types of training programs and therefore include journeymen as well as semi-skilled helpers. The indication from the table is that the main training emphasis is on the shipfitting, welding, and pipefitting skills.

Community Sponsored/Public Supported Programs. Private yards reportedly have made some use of community sponsored/ public supported programs. The impact of these programs on the yards is also indicated in Table 58 under "Other Programs." The greatest effect has been on the supply of welders and shipfitters.

Most of these community programs were established under the Manpower Development and Training Act of 1962 (MDTA), as amended, and the National Alliance of Businessman's JOBS Program (NABs-JOBS). The intent of these programs was not primarily to increase the skill content of the nation's work force, but rather to redistribute income toward disadvantaged minorities. The goal was to upgrade low-income workers so they might be able to hold semi-skilled jobs or be provided some pre-apprentice training.

In 1974, the Congress passed the Comprehensive Employment and Training Act (CETA). This program differs from its predecessor, MDTA, in that grants are given to local political jurisdictions for manpower programs as they deem necessary.

Table 58. TRAINING OUTPUT, SHIPYARD AND COMMUNITY PROGRAMS, PRIVATE AND NAVAL SHIPYARDS, JUNE 1972-JUNE 1973

Occupation	Private Shipyards				Naval Shipyards*	
	Shipyard Output		Other Programs		Shipyard Output	
	Number	Percentage of Employment	Number	Percentage of Employment	Number	Percentage of Employment
Shipfitter	486	7.6	353	5.5	55	2.9
Welder	1,400	17.4	409	5.1	68	2.6
Machinist	200	3.8	4	0.1	189	2.7
Electrician	122	3.8	--	--	117	3.1
Sheetmetal Worker	138	7.0	--	--	43	2.4
Pipefitter	347	8.8	4	0.1	130	3.1
Electronics Mechanic	--	--	--	--	108	5.0
Loftsman	3	1.3	--	--	1	1.0
Rigger	11	0.4	--	--	35	1.6
Boilermaker	4	0.9	--	--	19	2.0
Totals	2,711	8.2	770	2.3	765	2.9

*Naval Shipyards employed no graduates from any of the community training programs.

Source: Mark Battle Associates, Inc., *Shipbuilding Manpower Study*, Table 30, p. 87, March 1974, prepared for U.S. Department of Commerce, Maritime Administration, Office of Advanced Ship Development, Washington, D.C.

The increased local input into the decision-making process promises to make these programs more responsive to local needs. As a result, CETA may be more successful and may be able to affect significantly the shipyard manpower situation in some labor markets.

The caution expressed as to the net effect of CETA on shipyard manpower is due to three factors. First, the graduates of these programs are not required to take jobs in any particular industry, including the shipyards. With wages in the yards below those offered elsewhere, it is to be expected that if job openings exist, many trainees will seek work in other industries. Second, many of the nation's shipyards are located in areas in which they provide but a small portion of total area employment. If only by virtue of the shipyards' relative size in their respective area economies, the probability of a worker trained in public programs finding his way to the yards in many cases may be quite small. Third, these programs do not produce journeymen, though there are provisions to subsidize apprentice training. Thus, effective apprentice training, from the point of view of the shipbuilding industry, is dependent upon the shipyards' willingness to undertake formal in-house training programs.

b. Training in the Naval Yards

Training output in the naval shipyards is almost exclusively the result of apprentice programs to upgrade workers to journeymen and to supervisory positions. As indicated in Table 58, naval yard training occurs quite evenly across many occupations, rather than being concentrated in just a few occupations, as in the private yards. Table 59 gives the total number of apprentices in each naval yard and their numbers relative to journeymen.

Table 59. NUMBER OF APPRENTICES AND APPRENTICES AS A PERCENTAGE OF JOURNEYMEN, NAVAL SHIPYARDS, 31 March 1974

Naval Shipyard	Number of Apprentices	Apprentices As a Percent of Journeymen
Portsmouth	169	7.8
Philadelphia	495	15.0
Norfolk	763	17.2
Charleston	624	23.4
Long Beach	405	11.4
Mare Island	386	11.9
Puget Sound	540	13.0

Source: Naval Sea Systems Command, *Statistics on Naval Shipyards (SONS)*, March 1974, Productivity Performance Evaluation Division, Manpower Utilization Branch, Washington, D.C.

c. Summary

Various types of training programs take place in many of the nation's shipyards. However, most shipyards, especially those that are repair oriented, have no continual, formal in-house program. Apparently, these shipyards are reluctant to invest in training programs because of high quit rates among graduate trainees and a high variance in workloads that results in frequent layoffs. The status of training programs in the private yards indicates that these shipyards will be unable to train additional journeymen mechanics in the quantities needed to meet anticipated demands.

Because of low wages, coupled with the relative unimportance of many shipyards in their respective area economies, employment in a large number of shipyards will not be significantly affected by CETA or other public-sponsored training programs. Only shipyards in areas such as Newport News-Norfolk or Beaumont, where

the yards employ a rather large percentage of area labor, will these types of programs be of significance to the industry. In all others, higher wage rates seem to be the overriding factor in the attraction and retention of a skilled work force, as economic theory and the empirical evidence suggest.

E. TURNOVER: AN ANALYSIS

1. Purpose and Scope

The manpower demand and supply characteristics of the U.S. shipbuilding and repair industry have been documented and analyzed in the previous sections of this chapter. It has been concluded that a shortage of skilled shipbuilding manpower exists because of the recent surge in shipbuilding demands. This shortage, in terms of the inability to hire workers in sufficient numbers, is likely to persist. A major reason given for this latter problem is the low wage rates paid in the nation's shipyards. This is consistent with what economic theory predicts.

In its report on the capabilities of the shipbuilding and repair industry, the Office of Management and Budget acknowledged a strong relation between turnover and wage rates. However, the report claims that there is a lack of empirical verification of this relation: "It is generally assumed that the main reason for shipyard turnover is low pay. While this is felt to be true, there is no conclusive evidence to support this assumption."[1]

The primary intent of this section is to develop evidence to support the relation between turnover and wage rates. In doing so, three objectives have been set:

(1) To determine the significance of the relation between wage rates and the shipyard manpower retention problem.

[1] *Shipyard Capabilities Study*, *op. cit.*, pp. 142-43.

(2) To determine the significance of other factors in this retention problem.

(3) To estimate the extent to which shipyard manpower retention rates can be increased, i.e., turnover rates reduced, by the adoption of a competitive wage posture.

The analysis is presented in two parts. In the first part, evidence on the interindustry relation between wages and turnover rates is discussed. The intra-industry situation is treated in the second part, including an analysis of data relating to individual shipyards and local labor markets. Utilizing data for 1958-73, linear regression techniques were employed to test the turnover-wage relationship.

2. Analysis of Shipyard Quits and Other Separations (At the Industry Level)

a. Quit Rates

Several investigations have demonstrated that interindustry differences in wage rates and in quit rates are related. In one study, conducted by the Organisation for Economic Co-operation and Development (OECD), experiences with various forms of labor mobility in many of the industralized nations were examined. The analyses correlated a labor-mobility variable with each of several labor market characteristics, one at a time. Quit rates, for example, were correlated first with wage rates and then with the extent of union organization. The study stated:

> One of the most significant findings of this study is that when the association between earnings levels and labour turnover is examined, it turns out to be consistently of negative sign, and with high and usually statistically significant values of the correlation coefficients.... The United States figures relating to quits (voluntary mobility) show a still stronger association than do those relating to total separations....[1]

[1]Organisation for Economic Co-operation and Development, *Wages and Labour Mobility*, Paris, 1965, p. 52.

In another study, rank correlations between average hourly earnings and quit rates in twenty-three U.S. manufacturing and mining industries were computed for each of the years 1949 through 1962.[1] The rank correlation found for every year was negative and significant at at least the .05 level.[2]

These studies, while providing evidence on this relationship, are unsatisfactory in that they were conducted by correlating pairs of variables. Since other variables were not controlled, it is impossible to determine if quits were actually affected by wages or rather by other variables that were themselves correlated with wages. For example, in another part of the study just cited, Ulman reports that changes in wage rates and employment changes by industry are correlated.[3] A recent Mark Battle study has also demonstrated the significance of the relation between turnover (quits plus discharges) and employment growth in the shipbuilding and repair industry.[4]

In another study, quit rates in fifty-two U.S. industries were analyzed, controlling for several other variables.[5] The list of controls included new-hire rates, the age, sex, and skill composition of the industry's work forces, and the

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[1]The rank correlation coefficient is a measure of dependency between two variables that does not depend on the distributions of the variables. Such a measure is frequently referred to as a "nonparametric" statistic. The standard references are, C. Spearman, "The Proof and Measurement of Association Between Two Things," *American Journal of Psychology*, 15, 1904, pp. 72-101; and E. G. Olds, "Distributions of Sums of Squares of Rank Differences for Small Numbers of Individuals," *Annals of Mathematical Statistics*, 9, 1938, pp. 133-48.

[2]Lloyd Ulman, "Labor Mobility and the Industrial Wage Structure in the Post-war U.S." *Quarterly Journal of Economics*, vol. 79, no. 1, February 1965, pp. 73-97.

[3]*Ibid.*, pp. 94-95.

[4]"Preliminary Assessment of Manpower Availability in the U.S. Ship Construction Industry," *op. cit.*, pp. 23-35.

[5]Vladimir Stockov and Robert Raimon, "Differences in Quit Rates Among Industries," *American Economic Review*, vol. 58, December 1968, Part I, pp. 1283-98.

aggregate unemployment rate. Quit rates and earnings were found to be negatively related and significantly so. Quantitatively, the study concluded that at the means "a 1 percent increase in rewards has the effect of reducing the quit rate by 1.08 percent."[1]

Some analysts may contend that these studies refer to all, or to the average of all, industries. As such, the findings would reflect average behavior and not that of any one industry. To counter this argument, the quit rates in private shipbuilding and repair facilities (SIC 3731) were correlated with the industry's relative earnings position to all durable goods producing industries. The data are from the BLS publication *Employment and Earnings* and cover the time period 1958-73. The quit rate used is the annual average on a monthly basis displayed in Table 47 above. The relative earnings position (RELWAGE) is measured by the average hourly earnings in SIC 3731, divided by the average for all durable manufacturing industries. Since quits are expected to respond to overall job opportunity, the U.S. aggregate unemployment (UNEMP) is also included.

The correlation results, obtained by linear regression techniques, are shown here with t values given in parentheses.

$$\text{QUIT RATE} = \underset{(5.84)}{9.961} - \underset{(-3.44)}{5.241}\ \text{RELWAGE} - \underset{(-6.97)}{0.373}\ \text{UNEMP}$$

$$R^2 = .85$$

$$F = 35.43$$

$$df = 13.$$

All coefficients, including the intercept, are significant at the .01 level.[2] The earnings elasticity of quits at the

[1] *Ibid.*, p. 1298.

[2] With 13 degrees of freedom, the critical t value for significance at the .01 level is 3.01. The critical F value, at this significance level, is 9.07.

means was computed and found to be 2.816.[1] Based on these results, a 1 percent increase in the earnings in the shipyards, relative to that in all durable goods producing industries, can be expected to result in a 2.8 percent reduction in the average monthly quit rate in the shipbuilding industry, or a 33.6 percent reduction in the annual (sum of the monthly) quit rate.

The criticism made of the OECD and Ulman studies also applies here. That is, there are some uncontrolled variables that are often correlated with wage rates. The coefficient of RELWAGE then describes the total impact if all these variables move together. On that basis, it is possible, and in fact, quite likely, that the estimate obtained here is upward biased--that it overestimates the true or "pure" effect of earnings on quits. However, an over-estimation by as much as 50 percent still implies a substantial reduction in quits from a moderate wage increase.

b. Rates of Other Separations

The relation between relative earnings and the rate of other separations was also examined. It was noted earlier that in recent years the rate of other separations in the shipbuilding and repair industry had increased and is now substantially above the rates in most other industries. This form of turnover is caused largely by discharges and retirements.

[1]The "earnings elasticity of quits" measures the responsiveness of a percentage change in quits to a percentage change in earnings: % change in quits ÷ % change in earnings. A 1 percent change in earnings generating a 1 percent change in quits yields an elasticity measure (number) equal to one. A 1 percent change in earnings generating a larger than 1 percent change in quits yields an elasticity measure (number) greater than one. This is interpreted as a substantial degree of responsiveness between the variables. A 1 percent change in earnings generating a smaller than 1 percent change in quits yields an elasticity measure (number) less than one, interpreted as a slight degree of responsiveness between the variables. The normal relationship between the variables is inverse; hence the sign is usually negative.

The evidence presented earlier pointed to potentially high retirement rates in the naval, but not necessarily in the private, shipyards. The implication then is that the increase in this turnover rate in the private shipyards reflects higher discharge rates.

This possibility was tested by using least-squares linear regression analysis to relate the rate of other separations for private shipbuilding and repair facilities to the industry's relative earnings position (RELWAGE) for the time period 1958-73.[1] The U.S. aggregate unemployment rate (UNEMP) was also included, based on the assumption that this rate can serve as an index of the quantity of qualified workers available. It was therefore expected that this unemployment rate would be inversely related to discharge rates.

The results, obtained by linear regression techniques, are shown here, with t values given in parentheses.

$$\text{Rate of Other Separations} = \underset{(10.06)}{1.968} - \underset{(-7.41)}{0.171}\ \text{RELWAGE} + \underset{(0.44)}{0.22}\ \text{UNEMP}$$

$$R^2 = .87$$

$$F = 41.20$$

$$df = 13.$$

While the coefficient of the unemployment rate is positive, the opposite of that expected, it is not significant. The coefficient of the relative earnings variable is negative, as expected, and is significant at the .01 level.[2] This, plus the high R^2, supports the assumed theoretical relationship between earnings and discharges. It provides additional evidence that, perhaps, the increase in the rate of other separations is not due to greater retirement rates. Retirement rates are related to the age distribution of the work force and not

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[1]*Employment and Earnings, op. cit.*

[2]The critical t value for significance at the .01 level is 3.01.

the current relative earnings position. In other words, had the relative earnings variable not been significant, then higher retirement rates could have been the probable cause for the increase in the rate of other separations.

In sum, the evidence presented strongly substantiates the "assumption" of a wage-turnover relationship.

3. Analysis of Shipyard Quit and Discharge Rates (In Local Labor Markets)

A further analysis of the wage-turnover relation based on individual shipyard and local labor market data was undertaken using linear regression methods. The shipyard data used here are from the Mark Battle Associates' *Shipbuilding Manpower Study*. The labor market data are primarily from various Departments of Labor and Commerce publications. Data were collected for thirty shipyards along the Atlantic and Pacific Coasts.[1] A listing of these yards by labor market is given in Figure 47. Variables considered in the analysis are listed in Figure 48. Results of the analysis are displayed on Table 60.

Though the coefficient of the wage variable always had the expected sign, it was never significant at an acceptable level. The coefficient in Equation 1 (Table 60), in which the entire sample was used, was the closest to significance. However, as indicated by the results of the other equations, this probably could reflect the differences between naval and private shipyards with respect to wages and turnover, highlighted earlier.

One reason, and possibly the major one, for the lack of a statistically significant relationship is the small variance of the earnings variable (RELWAGE) relative to the variance of the labor turnover variable (TOR). The standard deviation of

[1]Turnover data were not available for shipyards along the Gulf Coast. Inland shipyards were not included because they are not likely to play a large role in the construction of most major vessels or in the naval repair workload. The Pearl Harbor Naval Shipyard was also not included.

Labor Market	Shipyards
Providence, Rhode Island	General Dynamics Electric Boat Portsmouth Naval Yard
Boston, Massachusetts	Bethlehem Steel Corporation General Dynamics, Quincy
Newark, New Jersey	Bethlehem Steel Corporation (Hoboken)
New York, New York	Brewer Drydock Company
Philadelphia, Pennsylvania	Sun Shipbuilding Company Philadelphia Naval Yard
Baltimore, Maryland	Bethlehem Steel Corporation (Sparrows Point) Bethlehem Steel Corporation (Key Highway) Maryland Drydock Corporation
Newport News/Hampton, Virginia	Newport News Shipbuilding and Drydock Norfolk Shipbuilding and Drydock Norfolk Naval Shipyard
Jacksonville, Florida	Jacksonville Shipyards
Seattle/Everett, Washington	Lake Union Drydock Company Lockheed Shipbuilding and Drydock Company Todd Shipyards Puget Sound Naval Shipyard
Portland, Oregon	F. M. C. Corporation Duwamish Shipyard, Incorporated Northwest Marine Ironworks
San Francisco, California	Bethlehem Steel Corporation Triple A Machine Shop Corporation West Winds, Incorporated Mare Island Naval Yard
Los Angeles/Long Beach, California	Bethlehem Steel Corporation Todd Shipyards Long Beach Naval Yard
San Diego, California	National Steel and Shipbuilding Company

Figure 47. LIST OF SHIPYARDS

Variable Name	Definition and Data Source
TOR	The sum of quit and discharge rates on an annual basis, for ten highly skilled occupations covering the period July 1972 - June 1973. Data are from Mark Battle Associates, *Shipbuilding Manpower Study, Appendices*, Volume 3, Appendix 1, March,1974.
RELWAGE	The shipyard journeyman wage rate expressed as a percent of that paid journeyman in the area non-construction industries. Data on shipyard wage rates are from individual collective bargaining agreements and are for wage rates in effect December 1973. Data for wages in the non-construction industries are from *Area Wage Surveys: Selected Metropolitan Areas. 1972-73*. BLS Bulletin 1775-97, October 1974. For each area the median wage rate for journeymen in occupations employed in the shipyards was computed and used here.
SHARE	A dummy variable designed to capture the importance of shipyard employment in the area labor market. The value of unity was assigned if the shipyard share of the area skilled work force was judged to be "high", zero if "average", and minus one if "low." The average value of SHARE over all yards should approximate zero. SHARE was assigned the value of unity when the shipyard share exceeded 5%, zero when between 3 and 5%, and minus one otherwise. The mean value of SHARE is 0.15. Data are from *Employment and Earnings* and the *Census of Populations*.
UNEMP	The unemployment rate in the local labor market for 1973. Data are from the *Manpower Report of the President*, April 1974, Table D-7.
UNION	A dummy variable assigned the value unity if the shipyard collective bargaining structure was that of an industrial union and zero if a craft union. Data were obtained from individual collective bargaining agreements.
REPAIR	A dummy variable assigned the value of unity if the shipyard was judged to be primarily engaged in conversion, alteration and repair work, and the value zero is engaged in new construction. Data were obtained from the NAVSEA, Office of Ship Production and Mark Battle Associates, *Shipbuilding Manpower Study*, March,1974.
SIZE	Production worker employment, June 1973. Data are from Mark Battle Associates. *Shipbuilding Manpower Study, Appendices*, Appendix 1, March, 1974.
J/P	Journeymen employment as a percent of total production worker employment. June 1973. Data are from Mark Battle Associates, *Shipbuilding Manpower Study, Appendices"*, Volume 3, Appendix 1.
PCST	A dummy variable set equal to unity if the shipyard is located on the Pacific coast and zero otherwise.
NEAST	A dummy variable set equal to unity if the shipyard is located on the Atlantic coast and in or north of Maryland, and zero otherwise.

Figure 48. VARIABLE NAMES, DEFINITIONS AND DATA SOURCES

Table 60. REGRESSION RESULTS, QUIT PLUS DISCHARGE (TOR) RATE DEPENDENT VARIABLE

		Coefficients[1]								Statistics			
Equation Number	Sample	RELWAGE	SHARE	UNEMP	J/P	SIZE	UNION	PCST	INTERCEPT	R^2	F VALUE	Degrees of Freedom	Critical t Value at .05 Level of Confidence
1	All Shipyards	-1.465 (-1.95)	-- --	-- --	-- --	-- --	-- --	-- --	198.05 (2.62)	.14	3.82	22	2.07
2	Private Shipyards	-4.496 (-1.24)	-25.373 (-1.37)	-- --	-2.529 (-1.66)	-0.008 (-1.70)	-- --	-119.716 (-3.23)	757.079 (1.82)	.50	2.60	13	2.16
3	Private Shipyards	-5.448 (-1.40)	-25.575 (-1.36)	-- --	-3.963 (-1.82)	-0.008 (-1.64)	-26.137 (-0.79)	-113.071 (-2.93)	903.081 (1.96)	.52	2.20	12	2.18
4	Private-North-east Only	-4.380 (-1.45)	-- --	-- --	-- --	-- --	-- --	-- --	435.015 (1.57)	.30	2.10	5	2.57
5	Private-Atlantic Coast Only	-3.247 (-0.75)	-21.520 (-1.18)	-32.655 (-2.36)	-- --	-- --	-- --	-- --	487.339 (1.12)	.49	1.96	6	2.45
6	Private-Pacific Coast Only	-3.320 (-0.63)	-- --	-- --	-- --	-- --	-- --	-- --	399.452 (0.80)	.05	0.40	7	2.36
7	Private-Pacific Coast & Southeast	-2.214 (0.51)	-40.812 (-1.50)	-- --	-- --	-- --	-- --	-- --	320.872 (0.78)	.25	1.51	9	2.26

[1]For definition of each variable, see Figure 48.

the RELWAGE variable equals 4.4 percent of its sample mean, whereas the standard deviation of the TOR variable is 85.1 percent of its sample mean. Therefore, in a statistical sense, RELWAGE could not explain much of the variance in TOR, over the time period considered, and was subsequently not found to be statistically significant.

The local area unemployment rate, UNEMP, was expected to be negatively related to TOR. While its coefficient typically was found to be negative, Table 60 reveals that it was never significant. In addition, several dummy variables were included in the analysis: SHARE, J/P, UNION, REPAIR, PCST, and NEAST. SHARE was included to capture the effect of the elasticity of labor supply on turnover. J/P was introduced as a proxy for the new-hire rate, arguing the higher this rate, the lower the percentage of the work force made up of journeymen. UNION was included to capture the effect of the difference in hiring and layoff practices in firms organized on an industrial versus a craft union basis. SIZE was designed to detect whether firm size had an effect on turnover behavior. REPAIR was included to test for differences that might exist between repair and construction oriented yards. Lastly, the regional dummy varibles PCST and NEAST were included to determine if any remaining unexplained regional patterns existed. With the exception of the regional dummy variables, all regression coefficients were expected to have a negative sign. All regression coefficients exhibited the expected sign. All of the variables, except for PCST, were not statistically significant.

4. Findings

When treating the shipbuilding and repair industry in the aggregate, shipyard earnings were found to have an inverse relationship to private shipyard quit rates and rates of other separations. Statistically this relationship was significant.

From a disaggregative perspective, using data on individual shipyards,[1] this inverse relationship was also found to exist, but, statistically, the relationship was not significant.

The lack of significance of relative shipyard earnings in the disaggregate analysis was found to result, in part, from the invariance of the relative wage positions in the shipyards. This points to the importance of including other variables in addition to or instead of earnings. Several other variables were included, and, with the exception of a variable indicating region (PCST), none was significant.

One possible explanation of these seemingly inconsistent results, especially as they apply to quits, may be called the "itinerant worker" hypothesis. Mention of an itinerant component of the shipyard work force has occurred in a number of discussions with shipyard personnel, but the study team found no documentation relating to this thesis.

Assume, however, that such a work force exists, that is, that there is a cadre of workers that tends to migrate from shipyard to shipyard as workloads fluctuate. As work in one yard approaches completion and hours worked begin to taper off, rather than await the eventual layoff, some workers quit and seek work in other yards. For this type of activity to flourish, there must be frequent and relatively large fluctuations in workloads. This is the case in many shipyards. Other industries with these workload and work force characteristics include construction and longshoremen. For itinerancy to exist, it is also necessary that there be several employers in the area.

The findings in the aggregate analysis are not inconsistent with this hypothesis. While the significance of the earnings variable indicates that there is some earnings-related inter-industry mobility, it does not preclude the possibility of

[1]See Figure 47 for the list of private and naval shipyards considered.

itinerancy. In the disaggregate analysis, variables needed to control for itinerant worker behavior were not included. Variables indicating the extent of recent fluctuations in shipyard workloads and near-term workload expectations are two candidates for use in analyzing the itinerancy factor. Whether there is a small or large number of yards in the area should also prove to be of importance.

In regard to the last variable, areas such as Bath, Maine, and Groton, Connecticut, can be described as having only one shipyard employer. While shipyard wages in these areas are relatively low, so are turnover rates (18 percent and 22 percent, respectively). On the other hand, San Diego has many shipyards and, National Steel, for example, pays a wage rate about 8 percent above the area average, but has a relatively high turnover rate, 54 percent.

This discussion cannot be viewed as presenting conclusive evidence in support of the itinerant-worker hypothesis, but it is clearly suggestive, and the hypothesis warrants further study.

The analysis presented in this section supports the following conclusions:

- Evidence presented indicates that at the industry level the relation between shipyard wage rates and the shipyard retention rate is significant.
- The large variance of turnover (quit and discharge) rates relative to the wage rates of yards included in this analysis strongly indicates the importance of other non-wage variables. Though several other variables were included in the analysis, none of any real interest was found to be significant.
- The effect of a moderate increase in shipyard earnings on shipyard quit rates was found to be substantial. The estimate obtained here, that a 1 percent increase in shipyard relative earnings would lead to a 33 percent decrease in annual shipyard quit rates, was judged to be upward biased. However, even if this estimate is two, or even three, times the true figure, it remains substantial.

5. Suggestions for Further Research

The findings of this analysis suggest that further research be undertaken. In particular, it is recommended that the "itinerant worker" hypothesis be investigated since it may have serious implications for public policy. For example, if the hypothesis is found to be of importance, then the link between high turnover rates and the lack of qualified skilled workers available to the shipyards at current wage rates is weakened.[1] Much of the turnover would then be due to the wide and frequent fluctuations in workloads experienced by many shipyards. Programs and policies aimed at increasing the stability of workloads would then have a major influence on retention rates of individual firms and, therefore, of the aggregate industry.

Data exist that may shed some light on this subject. The Social Security Administration collects and maintains a work history based on a 1-in-1,000 sample of employees in social security-covered employment. These data would provide some insight into the mobility patterns of a sample of workers, including some in the yards. This body of data is currently being analyzed by the Institute for Management Science and Engineering at the George Washington University, under a contract with the Office of Naval Research. Some preliminary results are expected by the end of the summer, 1975.

Another body of data that might prove useful to future researchers is a quarterly file of employment records collected by the Office of Civil Rights of the Maritime Administration. These data give, among other things, the age and length of service of each worker. If, over time, there remained a fair number of workers, say, 40 years of age, with short length of service, an itinerant factor would be strongly suggested. The

[1]This will not, of course, weaken the link between earnings and turnover. Rather, it implies that quits, regardless of their cause, may not be the best indicator of shipyard manpower problems.

number of firms who supply this information has diminished over time. It may be worthwhile for the Navy to determine if this sample could be expanded.

The Office of Civil Rights of the Maritime Administration also collects data on employment levels, hiring activity, and promotions by occupation, shop, race, and sex for a large number of shipyards. These data could prove useful in future research efforts, at least as an independent source of new-hire and turnover information. In addition, these data can provide insights into the effects of race and sex on labor supplies, in general, and on turnover, in particular.

F. CHAPTER SUMMARY, CONCLUSIONS, AND POLICY RECOMMENDATIONS

1. Chapter Summary and Conclusions

The purpose of this chapter was to analyze the shipyard labor market and to determine--

- The extent to which a shortage of skilled manpower exists or can be expected to develop in the next five years.
- The nature and characteristics of such a shortage, including the roles of wage and non-wage factors.
- Possible actions available to the Office of the Secretary of Defense to better assure the timely completion of naval workloads and to increase the cost-effectiveness of performance of shipyard work.

A shortage of shipyard manpower probably exists. Private shipyard manpower demands have increased rapidly in recent years. Coupled with the high degree of skill involved in some shipyard work, this increased demand indicates that time is needed for firms to adjust efficiently to the new market conditions. In addition, the industry is experiencing high rates of quits and other separations. In sum, it seems evident that the actual increase in industry manpower has fallen short of the desired levels.

Although manpower shortage may be plaguing the shipbuilding and repair industry, the shortage should not persist for any appreciable period. Manpower demands (measured in terms of equivalent men) in the private sector of the industry were projected by NAVSEA to grow by 5.2 percent in calendar year 1975, remain fairly constant through 1976, and fall in 1977. Not until 1978 were manpower demands expected to again increase.

Assuming that the length of the workweek remains unchanged and that all increases in equivalent men come from new hires, the projected average monthly new-hire rates would be 3.3 percent in 1975 and 3.0 percent in 1976. These projections cover not only the desired net increases in employment but also expected rates of attrition. Based on historical performance these new-hire rates seem attainable.[1]

The size of the shipyard retention problem and its influence on shipyard costs and performance led to a more detailed examination of the shipyard labor market. The examination was conducted in both an inter- and intra-industry framework. The analysis indicated that there are regional differences in shipyard labor supply elasticities. In general, labor supply is less elastic the larger the percentage of area employment accounted for by the shipyards. These areas include Newport News, Norfolk, Beaumont, and San Diego. Shipyards in these areas will encounter above average difficulties in attempting to increase employment.

Wage rates in both the private and naval shipyards vary across regions. Unlike other industries, however, there are no skill-based occupational wage differences in the yards. Wages in the naval yards exceed those in all private yards. Journeymen wage rates in the naval yards also exceed those paid in most area industries. Except for New Orleans and San

[1]Since this paper is being published subsequent to the end of calendar year 1975, IDA had the opportunity to verify the actual employment expansion in the private sector in 1975. The sector employment expanded 10.2% from 1 January to 31 December 1975.

Diego, private shipyard wages are below the area average. Both naval and private shipyard wages are below those paid in construction.

Quit rates in the private shipyard industry have typically exceeded those in other durable manufacturing industries. In addition, they have shown less variance. While quit rates are expected to reflect the level of job opportunity in the market, this seems to play a smaller role in shipyard quit activity than in most other industries. Rates for other separations, including discharges and retirements, are also high in the shipyards. Evidence was found indicating that above average rates of retirement could be expected in the naval, but not necessarily in the private, yards. It may be that these high rates of other separations in the private shipyards are due to high discharge rates.

Regional and occupational patterns of quit plus discharge rates were found to exist for both naval and private yards. Rates were consistently higher for welders and shipfitters, and in the Southeast and Los Angeles areas.

Formal in-house training programs exist in all naval yards, but in only a relatively small number of private shipyards, and then primarily in the major construction yards. Training seems to be a poor investment in the private shipyards because of high attrition rates among trainees and the large variance in workloads experienced by these yards. The main emphasis of these training programs is on the shipfitting, welding, and pipefitting skills.

Private yards have made use of community-sponsored training programs, especially for welding and shipfitting skills. These programs have included MDTA, NABs-JOBS, and more recently CETA. With respect to these programs, however, it appears that the emphasis has been on redistributing income toward disadvantaged minorities rather than on increasing the skill content of the labor force. As a result, these programs rarely produce journeymen. Their success, from the point of

view of the shipbuilding and repair industry, is therefore heavily dependent upon the shipyard's willingness to undertake supplementary, formal in-house training programs.

These and other labor market characteristics were then included in a quantitative analysis of shipyard turnover. This analysis found industry-wide quit rates to be significantly related to the industry's relative wage position, controlling for aggregate economic conditions. A one percent increase in the industry's relative wage position was found to lead to as much as a 2.8 percent decrease in monthly quit rates or a 33 percent decrease in annual rates. These elasticity estimates were judged to be upward-biased due to the lack of controls in the estimating procedure. However, even if the bias resulted in an estimate two or even three times the true elasticity, the wage rate effect would still be substantial.

Analysis of intra-industry differences in turnover (quit plus discharge) rates and relative earnings was not as successful. Relative earnings and several other labor market variables were analyzed and virtually none was found to be significant. One possible reason for this finding is the existence of an itinerant shipyard work force. While evidence that clearly supports the existence and significance of this type of a work force was not presented, the research was suggestive of the existence of such a work force. Further research into this area is recommended, because the existence of this type of work force would imply that high quit rates and the continued availability of experienced skilled workers are not necessarily mutually exclusive.

2. Policy Recommendations

a. Wage Rates

Our analysis demonstrates that the shipbuilding and repair industry's relative wage position affects the observed rate of quits and also suggests that wages and discharge rates are

related. Higher wage rates will clearly reduce the size of the shipyard employment retention problem. What is not clear is whether such a move would be economically justified. To determine this, the cost of incremental increases in wage rates must be compared with the cost savings resulting from reduced hiring and screening costs, shorter production periods (e.g., lower inventory costs), and possibly increases in labor productivity resulting from more learning. While we anticipate a favorable benefit-cost ratio, no quantitative evidence has been presented to support this assumption. It is therefore recommended that OSD, possibly in conjunction with the Maritime Administration and the Department of Labor, support studies of the U.S. shipbuilding and repair industry to determine benefit-cost relationships that would result from wage adjustments in the industry. The Defense Department has a strong interest in the entire industry because of the magnitude of the Navy's shipbuilding and repair programs.

b. Training

The larger the percentage of the total area labor force employed in the shipyard industry, the lower the shipyard labor supply elasticity, and therefore, the smaller the increase in labor availabilities and the smaller the reduction in quit or discharge rates resulting from a given wage rate increase. In these areas, greater training efforts may prove to be more cost-effective. However, to be successful, training efforts must either be totally in-house or community sponsored programs must be supplemented by in-house programs. In addition, the success of these programs will be directly related to the wage position of individual firms and the stability of the industry workload. It is, therefore, recommended that increased training efforts be viewed as a cost-effective method of increasing shipyard manpower supplies--but not necessarily

as a nationwide program. The cost-effectiveness will be greatest where area employment is most heavily concentrated in the shipyards and where shipyard wage rates are most competitive.

c. Workload Stability

The stability of the industry workload is a characteristic largely outside the control of most firms. Nevertheless, the unstable and uncertain nature of a shipyard's workload reduces incentives to undertake long-term fixed capital investments in either facilities or training (human capital). This fact, coupled with the skill intensity of the shipyard work force, means that virtually any sizable increase in demand will result in at least a transitional manpower shortage. The effect of this shortage on shipyard costs and adherence to production schedules is obvious.

One way to reduce the risk involved in shipyard business is to promote greater coordination between the Navy in the timing of its procurement policies and MARAD in the timing of its subsidy awards for ship procurement. These actions directly affect only new construction. However, since they impact on total industry workload demand, they have a substantial effect on the manpower and facilities available for depot maintenance.

Chapter VII

ANALYSIS OF SIGNIFICANT FACTORS AFFECTING THE COST-EFFECTIVENESS OF SHIPYARD OPERATIONS

This study has examined the U.S. shipbuilding and repair industry and Navy policies and procedures for assigning ship depot maintenance workloads. Shipyard industrial factors and relationships and Navy policies and procedures, all of which affect the cost-effectiveness of the accomplishment of the Navy ship-related workloads, were also examined.

This chapter treats several subjects that are important in terms of effective and efficient performance of Navy shipyard workloads. Many of the selected subjects necessarily relate to problems currently under study in DoD agencies. All of the subjects are treated here, however, to provide full coverage of the results of our analyses.

The subjects under discussion in this chapter have been grouped homogeneously into six general categories:

(1) Placing Ship Depot Maintenance Workloads in Naval and Private Shipyards

(2) Naval Shipyard Operations

(3) Navy-Private Sector Relationships

(4) Shipyard Capabilities and Capacities

(5) Placing Ship New Construction in Naval Shipyards

(6) Shipyard Performance Data

Within each category, subjects are discussed in a topical manner without regard to priority. Analyses of the various subjects are intended to be mutually exclusive, although we were not able to achieve this in every instance. In those cases in which an overlap was unavoidable, we have included cross-references to related topics.

For some of the subjects discussed, recommendations are made as to potential actions that are available to DoD now to improve the cost-effectiveness of the performance of shipyard work. For other subjects we believe that DoD must develop more information before corrective actions can be recommended. For these subjects, we have identified specific areas for further study.[1] Finally, several subjects are treated merely in the form of an evaluation without recommendation for DoD action.

A. PLACING SHIP DEPOT MAINTENANCE WORKLOADS IN NAVAL AND PRIVATE SHIPYARDS

1. Advance Planning

A comprehensive advance planning system has been developed to cope with the dynamic and complicated problem of scheduling ship depot maintenance. The Navy is currently testing several changes designed to make the system even more responsive to the unique requirements of shipyard operations.

Emphasis is currently placed on advancing key milestones in the planning cycle with the objective of providing sufficient lead time to permit--

(1) Ship inspection and development of the total work package, including integration of ship alterations and repair requirements.

(2) Completion of all design work.

(3) Ordering or fabrication and delivery of all material prior to ship arrival.

Since it is too early to assess the overall effectiveness of the Navy's recent changes, we have made no judgment of the total system. Several aspects of the planning system deserve further study, however; there may be opportunities to shorten the

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[1]In our recommendations for follow-on studies we have indicated that DoD should undertake these studies. DoD in this sense refers to the Department of Defense not the Office, Secretary of Defense. The specific organization to perform each study should be identified by the appropriate OSD staff agency.

overall process while retaining the potential advantages of the recently implemented changes.

a. The Length of the Planning Period

To be effective, milestone events must not be scheduled so far in advance that planning is characterized more by slippage than by adherence to the milestones. Generally, the shorter the advance planning period, the fewer the unpredicted events that will dictate change. The objective must be to begin the planning process early enough to permit essential tasks to be performed but late enough to reduce uncertainty to an acceptable level.

Generally, two factors determine the length of the Navy ship depot maintenance planning process:

(1) Preoverhaul tests and inspections have to be conducted far enough in advance to permit development of a detailed work package but late enough to assure that the work package accurately reflects the work required at the time the ship arrives for scheduled maintenance. Many factors determine the extent to which preoverhaul test and inspections are required to determine a ship's condition prior to arrival. For example, the technical competence of the ship's force, the accuracy of the Current Ship Maintenance Project, the extent to which standard maintenance requirements exist for the ship type, and the time elapsed since the last scheduled maintenance period must all be evaluated. Thus, it may be practical to schedule preoverhaul visits at varying times for each ship.

(2) The shortage of material and the attendant long procurement lead times must also be taken into consideration. As material becomes more readily available, the time required to order and obtain delivery of material required for depot maintenance should be reassessed and the start of the planning cycle adjusted accordingly. Also, it may be preferable to increase the use of prestocked items as a means of decreasing the length of the planning cycle. This approach requires that the cost of increased inventory levels be balanced against the potential delay in performing essential work items.

The planning period for overhauls to be accomplished in the private sector must include time for advertising the bid package and awarding the contract. These events must be accomplished early enough to give the private shipyard sufficient time to procure materials, adjust the labor force, and plan the overhaul. Contract awards a few days prior to the start of an overhaul or even thirty days, as is now the goal, do not appear to provide sufficient lead time to plan many overhauls properly. The magnitude and complexity of the work package are two factors that influence the contractor's need for time to prepare for an overhaul.

b. The Role of the PERA

The PERAs have become key agencies in ship depot maintenance planning. Their intended role of coordinator and manager of advance planning is vital to successful preparation for an overhaul. The PERAs are organized basically by ship type. We believe this is sound. We note, however, that different procedures and terminologies are used by various PERAs in carrying out their responsibilities. In our view, these procedures and terminologies should be standardized as much as possible. Standardization would facilitate the interaction of the PERAs with the many agencies concerned with ship depot maintenance.

There appears to be considerable variation in the activities performed by the PERAs and in tasks assigned to other organizations. A primary function of all PERAs and one that should not be delegated is active participation in the ship-inspection phase of advance planning. Only in this way can the PERAs acquire first-hand knowledge of a ship's condition and overhaul requirements.[1] We believe that the PERAs should be properly manned to conduct these inspections.

[1]PERA inspection teams would continue to be accompanied by naval shipyard or SUPSHIP personnel, but primary responsibility for performing the inspection should remain with the PERA.

In sum, the DoD should undertake a comprehensive study of the advance planning process to determine if the planning cycle can be shortened and the total amount of resources applied to this function reduced. Following are some of the questions that could be addressed in such a study:

(1) Should the responsibilities and authorities of the type commanders in the advance planning process be redefined? For example, should the PERA interact more directly with the ship involved and deal with the type commander on an exceptional rather than a routine basis?

(2) Should the PERA maintain a more comprehensive up-to-date data base on each ship similar to the Current Ship Maintenance Project? This would involve virtually continuous interaction among the ship, IMAs, and the appropriate PERA to maintain information on ship conditions.

(3) Should procurement and stocking procedures be revised to increase the use of prestocked long-lead-time items for ship depot maintenance?

(4) Should the PERA establish a more direct relationship with intermediate maintenance activities as part of the total planning process?

(5) Should all funds for scheduled ship maintenance be centralized in the logistic channel (with the Ship Logistic Manager, for example)? This action might facilitate maintenance planning and standardization for the entire Navy as opposed to the current policy of letting type commanders determine the priority of repair.

AREAS FOR FURTHER STUDY

- Explore ways to advance the contract date for ships to be overhauled in the private sector, so private contractors will have longer lead times to prepare for the overhaul.
- Perform a comprehensive study of the ship depot maintenance advance planning system to determine if the planning cycle can be shortened and the total resources applied to this function reduced.

2. Use of Interim Drydockings to Increase the Benefits of Split Bidding

Navy ships are put in drydock as an integral part of a regular overhaul. New ships entering the fleet are increasing in size and complexity, e.g., the DD-963 class destroyers. For the foreseeable future, these new ships will have to be overhauled in naval shipyards because very few private shipyards have the facilities and manpower skills to accomplish these overhauls. Unless manpower ceilings are raised and greater drydock capability provided in the naval shipyards, this increased workload may make it necessary to overhaul more of the less complex Navy ships in private shipyards.

The Navy Repair Manual requires that field contracting officers use split bidding whenever feasible. Under split-bidding procedures, contractors are permitted to bid on part of a total work package. Split bidding has several advantages:

(1) Lower total bid prices for Navy ship depot maintenance work because of the increased competition.

(2) More efficient use of private shipyard capacities since many small contractors who do not have the facilities and work force to accomplish a complete ship work package are able to bid on a part of the total job. For example, many contractors who lack a suitable drydock are able to accomplish complete topside work.

(3) Possible encouragement for small private contractors to upgrade facilities, expand skilled work force, and develop special repair capabilities.

On the other hand, if more than one contractor performs the work, split bidding may--

(1) Increase the time required to accomplish the total work package; for example, in some cases, it may be necessary to move the ship to another yard.

(2) Result in excessive delay or even cancellation of the second contract if the first contractor encounters excessive delay.

(3) Cause "gray" areas in contractor accountability if the two work packages are not accurately defined.

Two actions are proposed to offset the potential delays that the split-bidding system may impose on performance of depot maintenance workloads:

(1) Use interim drydockings, scheduled at regular intervals between overhauls, to accomplish required bottom work. To minimize loss of operating time, interim drydockings should be scheduled coincidentally with one of the maintenance periods currently scheduled by type commanders. Thus, the work required during scheduled overhauls would be restricted to topside work and urgent work on the bottom. (All other bottom work would be accomplished during the next scheduled interim drydocking.) Once the urgent bottom work is accomplished, the ship could be removed from drydock and topside work accomplished in the same yard or in another location, depending on the outcome of split bidding.

(2) Establish a dedicated drydock at one or more naval shipyards to perform only interim drydockings. This facility, with the necessary equipment and manpower, would operate on a three-shift basis and utilize the latest hull-blasting and propeller, rudder, and shaft-handling equipment to expedite the turn-around of ships. Quasi-production line techniques could also be employed.

In sum, an interim drydocking policy, implemented in conjunction with continued use of split-bidding procedures, can produce both lower prices for ship depot maintenance work and increase the capability of the private sector to accomplish Navy workloads.

RECOMMENDATION

- For those ships for which it is feasible, the Navy should adopt an interim drydocking policy to increase competition and reduce the time required for drydocking during a regular overhaul.

3. Home-Port Policy

The Navy's home-port policy requires that Navy ships be overhauled and repaired in or as close as possible to their

operating home ports.[1] Thus, a ship's home port is a major consideration in developing ship depot maintenance schedules. The home-port policy is designed to maintain morale of the ship's crew and improve the military personnel retention rate, which in turn results in more experienced personnel and lower training costs.

Offsetting these lower costs are potentially higher costs for some Navy shipwork because workloads are concentrated in home-port areas. The potential for higher costs is particularly true in Navy home-port areas such as Norfolk and San Diego. In these and similar areas of ship concentration, scheduled and unscheduled ship depot maintenance work and ship new construction compete for limited shipyard resources.

We recommend retention of the home-port policy because it is a very strong influence in helping to maintain ship crew morale. We believe, however, that further research is required to identify alternatives that would permit retention of the home-port policy while alleviating the current concentration of Navy workloads in home-port areas. Among the areas to be considered are the following:

(1) Adoption of a policy of assigning ship new construction outside of the major home-port areas whenever the capability exists elsewhere to accomplish the new construction. This would make a larger percentage of the facilities in home-port areas available for repair work.

(2) Development of revised basing policies to provide added opportunity to redistribute ship repair workloads.[2]

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[1]For overhauls of twelve months duration or longer, the Navy has a policy of temporarily changing the ship's home-port to the shipyard. This practice, however, benefits only the individual whose family circumstances permit him to relocate his family for the period of the overhaul.

[2]The authors recognize that the Navy has devoted considerable study to the home-port policy. Nevertheless, considering the impact of this policy on ship overhaul programs and the dynamic characteristics of the ship repair industry, it is appropriate to conduct a new review of ship-basing policies.

These alternatives deserve examination in the interests of conserving limited ship-repair resources.

AREA FOR FURTHER STUDY

- Examine alternatives that would retain the home-port policy but reduce the heavy workload concentration in home-port areas.

4. Fixed-Price Policy for Ship Depot Maintenance

In dealing with naval shipyards, the Navy assumes that the true condition of the ship is generally not known until about half-way (50 percent) through the scheduled maintenance period, when the amount of work required on equipment scheduled for "open, inspect and repair" is determined. As a result, naval shipyards essentially work on a cost-reimbursable basis until the 50-percent point, at which time they are required to make a fixed-price offer. The Navy decision to require a fixed-price offer at the 50-percent point appears to be an effective way to provide flexibility in dealing with a situation that involves a high degree of uncertainty.

Current contracting procedures do not permit the Navy to work with private shipyards on a cost-reimbursable basis for a part of a ship overhaul, even though the same uncertainty in the amount and cost of work required exists as for the naval shipyard. SUPSHIP personnel are required to write detailed work specifications for every task to be performed during the overhaul.[1] As a result, work that cannot be defined in detail until after inspection is either excluded from the initial work package or included as an "open, inspect and report" job. Private contractors must make a fixed-price offer at the time the contract is awarded based on the initial work package. Thus, any work identified at a later time, such as a requirement for

[1]Needless to say, this procedure has a significant impact on SUPSHIP manning requirements.

repair after an "open and inspect" work item, becomes the basis for a contract change order and subsequent negotiation.

The approach used in dealing with naval shipyards acknowledges the uncertainty and, at the expense of some loss of control by the customer, provides flexibility in the first half of the overhaul. The approach used in dealing with private shipyards emphasizes control by the customer (the Navy in this case) throughout the overhaul, as a means of handling the uncertainty, at the expense of lost flexibility and increased time to identify and process change orders.

We were unable to examine the full implications of these contrasting approaches to dealing with a situation that involves a high degree of uncertainty in terms of the amount and cost of work actually required during an overhaul. We concluded, however, that a more detailed analysis might identify changes in existing procedures that would provide the opportunity to improve the efficiency of shipyard operations.

Requiring naval shipyards to provide a fixed-price offer at the start of an overhaul would--

(1) Provide a producer-customer relationship within the Navy that is closer to the relationship that exists between the Navy and private shipyards. This would impose greater discipline in the performance of the entire work package at the expense of higher administrative cost.

(2) Force improvement in work package and work specification preparation. This would provide improved knowledge of the work required during overhaul as a basis for improved manday and material estimating and workload scheduling.

(3) Highlight the difficulty of providing manday and cost estimates before the work is identified and, perhaps, lead to improved data bases.

(4) Emphasize the need for standard work items and prices in work packages.

Any advantages gained by adopting a fixed-price policy at the start of overhaul in naval shipyards would be achieved, at

least initially, at the expense of increased delays resulting from loss of flexibility.

Providing increased flexibility on contracts with private shipyards might be feasible if standard work items could be developed. Based on those standards, options could be incorporated into the basic contract that would provide, for example, "repair" options to follow as a result of data obtained during an "open and inspect" requirement. If prices were established in advance for each of these options, the existing change-order system could be simplified.

AREAS FOR FURTHER STUDY

- Analyze current procedures for contracting with naval and private shipyards to determine benefit/cost relationships between the two systems with regard to fixed-pricing.
- Devise ways to increase flexibility in private shipyard contracts to facilitate processing of change orders and supplemental work.

5. The 70/30 Allocation of Navy Ship Depot Maintenance Between Naval and Private Shipyards

In general, current Navy policy is to divide total depot level shipwork (including conversions) between naval and private shipyards in about a 70/30 ratio based on total dollar value. Although the Navy opposes rigid limitations on the division of work between naval and private shipyards, it has elected to pursue a policy of a 70/30 split based on the general *guidance* of DoDD 4151.1 and, apparently, in response to pressures from Congress and the private shipbuilding and repair industry.[1]

[1]See U.S. Congress, House, Committee on Armed Services, Subcommittee on Seapower, *Current Status of Shipyards, 1974,* 93rd Cong., 2nd sess., July-October 1974, Part 1, p. 13; and Chapter V, Section A of this paper.

As described elsewhere in this study, unused depot maintenance capacity in terms of equipment and facilities exists in naval shipyards. Despite this unused capacity, the Navy assigns shipwork to the private sector in accordance with its 70/30 allocation policy as an alternative to increasing manpower levels in naval shipyards. The extent to which this decision affects the efficiency of naval shipyard operations was not determined in this study. It is reasonable, however, to expect the cost-effectiveness of naval shipyard operations to improve if presently unused capacity is utilized to accomplish incremental ship workloads. This approach, of course, must consider the cost-effectiveness implications for private shipyards if workloads are increased in the naval shipyards at the expense of corresponding decreases in the private sector.

We recommend that DoD examine alternative allocations of Navy ship depot maintenance workloads in both naval and private shipyards. Such a study should consider projected peacetime and war-mobilization requirements and determine the most cost-effective alternative for accomplishing Navy ship workloads. That alternative should then be adopted for placing Navy ship workloads in both naval and private shipyards.

RECOMMENDATIONS

- The Navy should define and publish the criteria used to determine the amount of support, in terms of shipyard capacity, required from the private sector in peacetime and planned for wartime.
- The Navy should place Navy ship workloads in naval and private shipyards to achieve maximum cost-effectiveness regardless of the final distribution of work between these two categories of shipyards.

6. The Master Ship Repair Contract System as a Management Tool

To be eligible to perform work on naval ships, a private contractor must hold a Master Ship Repair Contract (MSRC). This

contract establishes in advance the terms under which the private contractor will perform Navy shipwork under job orders issued at the time work is required. Section F of Chapter III discussed the contractual procedures for placing shipwork in the private sector. Section F pointed out that under these procedures marginal contractors have received contracts for Navy work when in the best interests of the Navy, these contracts should have been awarded to more highly qualified, proven private shipyards. We have reviewed the use of MSRCs to facilitate placement of Navy work and recommend the following changes:

(1) Categorize MSRCs according to specific work categories (e.g., type of ship and job) that are candidates for assignment to the private sector. Define specific criteria for each category in terms of facilities, manpower levels, trade skills, and support services required.

(2) Conduct on-site surveys to rate each private contractor who seeks Navy shipwork on his ability to perform work under specific MSRC categories. Award an initial MSRC covering each category of work the contractor is qualified to perform.

(3) Publish a consolidated list of all holders of MSRCs showing the categories of work for which each contractor is qualified and, perhaps, a record of the number of times he responds to work proposals. This latter information, together with data on contracts received, would provide some indication of the contractor's responsiveness to Navy work.

(4) Perform periodic follow-on surveys of each private establishment to assure that the list reflects current qualifications.

(5) Revise current requirements to include certification of major sub-contractors used by MSRC holders. Sub-contractors frequently used could be handled the same as prime contractors.[1]

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[1]It may be more practical, in lieu of an on-site survey, to require prime contractors to provide a guarantee for sub-contractors used on an infrequent basis. Even in these cases, however, the same criteria defined above would be applied.

(6) Include in the specifications for each work package to be assigned to the private sector detailed requirements based on the criteria for the applicable work package. Conduct pre-award surveys based on these criteria such that each bidder must provide evidence of current capability to perform, both for himself and for sub-contractors used on an infrequent basis.

The above recommendations retain the advantages of current procedures while adding the following new advantages:

(1) Each private contractor would know which category of work he is eligible to perform and the improvements required to qualify for additional categories.

(2) Ship depot maintenance managers at all levels would have a comprehensive document identifying the capabilities and capacities in the private sector to perform Navy workloads.

RECOMMENDATION

- The procedures for awarding Master Ship Repair Contracts should be changed to improve their value as management tools to help insure that complex overhauls are assigned to the best qualified private contractors.

B. NAVAL SHIPYARD OPERATIONS

1. The Industrial Fund Concept

In addition to providing a more effective means of financing, budgeting, and accounting for the costs of operating industrial activities, the Navy Industrial Fund is designed to be a management system. Successful operation under the NIF concept involves--

(1) Creating producer-customer relationships in the Navy comparable to those that are achieved by efficient private enterprises in similar types of activities. These relationships are designed to provide managers and customers incentives for efficiency and economy.

(2) Providing managers of naval shipyards the financial authority and flexibility to procure and use manpower, materials, and other resources as required to coordinate labor force and inventories with workloads assigned.

There are indications, however, that the NIF has become essentially an accounting system with limited use as a management system.[1] In fact, many congressional, DoD, and CSC policies under which shipyards are operated limit rather than encourage maximum cost-effectiveness.

We recommend that the DoD reevaluate the operation of naval shipyards under the NIF to provide shipyard commanders the authority and flexibility required to operate as industrial facilities in a competitive environment. Among the changes to be considered are the following:

(1) Removal of manpower constraints so the funds allocated to shipyard customers become the primary determining factors for shipyard employment levels.

(2) Removal of all CSC and DoD constraints that prevent shipyard commanders from adjusting quickly the total work force to accomplish actual workloads. Permit shipyard commanders to determine employment levels and mixes subject only to the available labor supply. A possible interim solution would be to establish employment ceilings on a permanent cadre and remove temporary employees from authorized ceilings.

(3) Permit individual naval shipyards to submit "bids" for overhaul of ships scheduled to be assigned to either private or naval shipyards. This proposal could be used either as a basis for assigning the ship or for evaluating the cost and manday estimates submitted by other shipyards.

(4) Make the shipyard commander responsible only for those activities that are required for ship depot maintenance. All other activities should either be transferred from the shipyard or assigned to other command channels.

(5) Permit shipyard commanders to establish research and development programs directed toward improved industrial procedures in shipyard operations. New techniques for accomplishing ship overhauls would not only benefit naval shipyards but would also emphasize the role of the Navy as the "leader" in the ship repair industry.

(6) Modify the NIF cost accounting system to provide expanded use of cost centers and cost classes to assure increased visibility into (a) all nuclear-related

[1]Though the subject is beyond the scope of this investigation, the same may generally be true of the entire DoD industrial fund system.

costs; (b) non-productive time; and (c) cost of all standby capability (i.e., not required for current workload).

If such changes are not adopted DoD should reassess the need for imposition of the industrial fund system on naval shipyards. Less complex and expensive procedures may be available to achieve the desired producer-customer relationships provided by the industrial fund. For example, a system could be established to fund naval shipyards directly from applicable appropriations or through reimbursements and provide customers' budgets in the form of authorized mandays for shipyard work. Naval shipyards could continue to use industrial cost accounting systems, but much of the added procedural requirements of the industrial fund system could be eliminated.

RECOMMENDATION

- DoD should increase the shipyard commanders' authority and flexibility to operate shipyards as industrial facilities in a competitive environment under the NIF.

AREA FOR FURTHER STUDY

- Reevaluate the application of the NIF system to naval shipyards if shipyard commanders are denied greater flexibility for operating under the NIF.

2. Funding Overhauls on an Annual Basis

A major portion of ship overhauls is paid for by O&MN funds[1] controlled by the fleets. These funds are appropriated on an annual basis and, in general, *must* be obligated in the same year. While this procedure facilitates control of funds, it complicates the overhaul scheduling problem. One-year funding for work that must be planned and scheduled well in advance of ship arrival is not sufficient to assure stable workloads. In

[1] See Chapter II.

addition, one-year funding does not provide adequate incentives for private shipyards to make capital investments in long-range projects. For these reasons, one-year funding for overhauls is inappropriate.

We recommend that DoD initiate action to establish a Ship Overhaul Appropriation that would permit the Navy to fund scheduled overhauls on a three-year basis, similar to some procurement appropriations. The Navy should continue to fund fully the estimated cost of overhauls upon induction of ships into the shipyard; however, by extending the obligation period to three years the Navy would have desirable flexibility to adjust funds to meet unforeseen developments throughout the period of the overhaul.

The primary advantages of a multi-year approach to obligating funds for overhaul include--

(1) Provision to include allowances for escalation in the initial cost estimates and in contract costs.

(2) Provision of an incentive to shipyards to make capital investments to facilitate the overhaul of ships assigned as far in advance as three years.

(3) Elimination of the end-year scramble to obligate O&MN funds, as well as the problem of being unable to obligate money for ships scheduled for overhaul early in the next fiscal year until that fiscal year begins.

The Navy is already examining procedures that would permit a form of multi-year funding within the constraints of current O&MN policy.[1] The system recommended here would eliminate the need to fund multi-year programs from an annual appropriation.

RECOMMENDATION

- DoD should recommend to the Congress the establishment of a Ship Overhaul Appropriation with Three-Year Obligation Authority.

[1]Based on conversations with NAVSEA personnel, in POM 77 the Navy has provided advance funds for overhauls one and two (continued on next page)

3. Manpower Considerations in Shipyard Operations

This section evaluates several items related to manpower.

a. Ceilings

Naval shipyards currently operate under end-year manpower ceilings. Actual manpower levels for each shipyard are determined by the Navy in conjunction with the review and allocation of the total Navy strength authorized in the DoD budget. In recent years, manpower ceilings have limited the amount of work that could be placed in naval shipyards since these ceilings have been established at levels below peacetime capacity (e.g., the FY-75 ceiling was about 80 percent of capacity).[1] Assuming customer O&MN funds could have been made available, the manpower ceiling prevented more efficient utilization of naval shipyards since Navy ship depot maintenance workloads were available for placement in the yards.

Despite the usefulness of manpower ceilings as a means of controlling costs of government activities in general, we believe manpower ceilings on industrially funded activities such as shipyards are inappropriate. Manpower levels for these activities should be determined by the amount of work projected to be funded and assigned. Local management would then be provided the flexibility to adjust total manning as required to assure efficient application of labor.

We recommend that DoD examine the feasibility of revising manpower policies for naval shipyards to provide increased

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(cont'd) years in advance of ship arrival. The work for each year is identified as a discrete work package and paid for with annual O&MN funds for that year.

[1]As shown in Table 20 the naval shipyard capacity peacetime one-shift employment level is 76,700 employees for the "repair only" mission. The authorized end-FY 1975 employment level was 61,500 employees in the naval shipyards, or 80 percent of peacetime capacity. Under this circumstance, manpower ceilings result in the underutilization of facilities and equipment and contribute to higher overhead rates.

flexibility. Among the items to be considered are--

(1) Elimination of overall manpower ceilings.

(2) Exemption of apprentices from manpower ceilings. This provision would permit apprentice training levels to be determined separately, based on anticipated requirements for skilled labor.

(3) Exemption of temporary employees from manpower ceilings. This provision would increase the flexibility available to local shipyard management to vary the size of the total labor force based on the amount of work to be accomplished. Several alternatives appear feasible. For example, NAVSEA could be authorized a designated number of temporary billets, which could be apportioned among the shipyards according to projected, short-term variations in workload. Each shipyard commander would be authorized to hire and layoff short-term employees, within the limits of the temporary billets allocated, without approval from NAVSEA.

(4) Formulation of special CSC rules to facilitate use of temporary employees on a day-to-day basis without excessive paperwork and controls.

b. Expanded Job Training

Important benefits in manpower utilization could be achieved by establishing programs to train skilled shipyard workers in secondary trades. A first step in this direction is to ensure that each worker can perform as many skills as possible within his primary trade. The second step is to train workers in related trades. This procedure gives management the flexibility to move labor to the areas of greatest need. Implementation of this procedure would require overcoming labor-union resistance in some cases, but this program could be a significant action to promote more cost-effective operations.

c. Ship-Located Repair Work

Manpower utilization on ship-located repair work may be improved by employing teams composed of skilled labor representing various trades and shops to work on a total ship system

or large component. A supervisor from the lead shop on the job would be placed in charge of all members of the team. Individual shops would provide the required manpower on a scheduled basis or as modified by the team leader. This approach to larger jobs may offer opportunities to reduce lost time and provide more effective on-the-job supervision. Once again union resistance would be a factor to be overcome.

d. Shipyard Turnover Rates

Turnover rates in naval shipyards are significantly lower than turnover rates in private shipyards. However, it appears that a major part of this difference might be attributable to the existence of a group of private shipyard workers that tends to migrate voluntarily from shipyard to shipyard as workloads fluctuate. The possible existence of this labor pool has significant implications in estimating the total capacity of the private sector to accomplish Navy depot maintenance workloads.

e. Wage Rates in the Shipbuilding and Repair Industry

While wage rates in private shipyards are significantly lower than rates in naval shipyards, workers in private shipyards are paid at a level that is "generally comparable" to the economy-wide average. An examination of available data, however, indicates a deteriorating relative wage position. The impact of this situation on the overall ability of private shipyards to accomplish potentially increased workloads must be evaluated by the Navy.

AREAS FOR FURTHER STUDY

- Determine the extent to which an "itinerant component" of the shipyard work force exists and evaluate its implications for the shipbuilding and repair industry.

- Conduct a joint DoD-MARAD-Labor Department study of the U.S. shipbuilding and repair industry to determine benefit/cost relationships that would result from wage adjustments in the industry.

4. Naval Shipyard Utilization

In addition to their role in accomplishing scheduled depot maintenance, naval shipyards are required as an immediately available mobilization base and to provide a rapid response capability for emergent shipwork. As a result, naval shipyards possess a wide range and depth of facilities and equipment seldom found in private shipyards. This situation, combined with the current manpower ceilings imposed by the Navy and the policy of allocating 30 percent of the total ship depot maintenance workload to the private sector, results in unused capacity in naval shipyards.[1]

The employment of additional personnel in the naval shipyards on a single shift, forty-hour-work week basis until constraints for designated facilities are reached provides an opportunity to improve the overall performance of naval shipyard workloads.[2] Two advantages accrue from this approach. First, the facilities and equipment are in frequent use and, thus, are operational whenever an emergency need arises. Second, a trained work force is readily available as a cadre for rapid expansion.

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[1] See earlier discussions in this chapter of manpower ceilings and the 70/30 split, Sections B.3 and A.5, respectively.

[2] With respect to resumption of new construction in naval shipyards (see E below), one of two conditions could prevail for naval shipyards having a new-construction capability. First, the naval shipyards could be engaged in new construction and repair, thus they would be manned to capacity for performing these two types of work. In the second condition, the shipyards could be engaged only in repair with employment optimized for this function only. Under this condition, new-construction and any other facilities and equipment not used should be inactivated and financed separately as industrial reserve facilities.

RECOMMENDATION

- The naval shipyards should be permitted to employ additional personnel so facilities can be optimally workloaded.

5. Comparing Costs of Accomplishing Navy Ship Depot Maintenance in Private and Naval Shipyards

Despite the fact that a detailed comparison of the relative costs of Navy shipwork accomplished in private and naval shipyards was not included in this study, several significant conclusions were reached with respect to cost comparisons.

(1) Currently, comprehensive cost comparisons for work accomplished in private and naval shipyards are not possible without extensive research and analysis for each specific case. The DoD should establish the detailed data base that is required to support such comparisons on a routine basis. This includes, for example, data to support sensitivity of overhead costs to specific factors and cost elements. (Additional discussion of some of the data problems involved is included in Section F below.)

(2) Naval shipyards will not be competitive with private shipyards on the basis of costs unless the unfavorable impact of the Federal Wage System is eliminated (Section B.9 below).

(3) Naval shipyards will not be competitive with private shipyards on the basis of costs unless the DoD exploits the full potential of the Industrial Fund concept (Section B.1 above). For example, shipyard commanders must be provided increased flexibility and authority to establish and adjust employment levels as required to accomplish actual workloads in the most cost-effective manner.

(4) Once the above two actions are accomplished, it is reasonable to expect naval shipyards to be competitive with private shipyards on a cost-effectiveness basis.

6. Evaluating Naval Shipyard Performance

Generally accepted overall performance measures for industrial repair and overhaul activities, such as shipyards, do not

exist because of the difficulty of obtaining directly quantifiable measures of output and input. Consequently, conclusions derived from data about relative shipyard performance can be misleading unless the basis for comparison is carefully evaluated.

The procedures outlined in Chapter IV provide a reasonable basis for evaluating and monitoring shipyard performance pending the availability of improved input and output measures. Specifically, the Navy should--

(1) Define and publish performance indicators based on those presented in Section IV.B (see also Section F.1 below). These indicators would provide a standard basis for monitoring trends in naval shipyards in terms of performance efficiency.

(2) Develop and adopt the system described in Section IV.D as a means of evaluating the performance effectiveness of both naval and private shipyards.

(3) Expand its program to develop and implement the use of standards for shipyard maintenance operations. Increased availability of valid standards is vital to the establishment of a performance measurement system.

RECOMMENDATION

- The Navy should formally adopt the performance measurement concepts proposed in this study. This includes the development and publication of: performance indicators to monitor efficiency trends; data about the extent to which ships are completed on-time and at the negotiated cost; and an expanded work standards program.

7. Nuclear Versus Non-Nuclear Shipwork

Nuclear shipwork is probably more costly to perform than non-nuclear work primarily because of the special facilities and added safety and inspection standards required to support nuclear work. The following factors contribute to this cost relationship:

(1) An additional internal organization has been established in naval shipyards to manage nuclear work.

(2) Separate, rigid standards and procedures are applied to nuclear work. This requires additional proficiency training of personnel.

(3) One hundred percent inspection is required of nuclear work, thus--

   (a) The start-stop nature of the work is increased, which means more time is required to perform the job.

   (b) The number of quality assurance personnel required to perform inspections and tests is increased.

(4) Working with contaminated material requires more time than non-nuclear work because workers must--

   (a) Dress in protective clothing.

   (b) Go through decontamination procedures.

   (c) Be monitored for radiation received.

   (d) Plan the job and practice the job-order work on mock-ups to minimize exposure time in performing the actual repair and maintain quality of workmanship.

   (e) Be trained in radiological control.

(5) Equipment and facilities used in performing nuclear work must meet rigid standards not required for non-nuclear work.

Current cost accounting procedures do not provide sufficient detailed data to identify all of the costs attributable to many of the above requirements. The need to expand the amount of detailed information about the cost of nuclear-unique work that is available in the NIF cost accounting system is covered in the recommended reevaluation of naval shipyard operations discussed in Section B.1.

8. The Federal Wage System

The Federal Wage System does not achieve wage comparability between naval shipyard wage employees and their counterparts in local private industry. Wage rates established in accordance with the current system are the most important reason why naval shipyard costs for ship depot maintenance are higher than costs in private shipyards. Thus, naval versus private shipyard cost differentials could be reduced if the Federal Wage System were

revised to achieve true wage comparability between the two sectors. However, the Federal Wage System applies to all federal wage employees, so the need for revisions to the system should be evaluated in terms of the entire federal versus private sector wage structure relationship.[1]

We recommend that DoD evaluate the desirability of revising the Federal Wage System for shipyard workers to accomplish its stated objective of wage comparability between the private and federal sector, recognizing that such a revision would have to take account of many broader considerations not included in this study. The primary changes to be considered include the following:

(1) Using average wage rates for local private industry to establish the pay rate for the step of the majority of the federal wage employees rather than for step two, as is now required.

(2) Conducting a preliminary survey to identify, by trade, the actual geographical area in which federal activities compete for labor. Revise the criteria for the industries included in the survey and the boundaries of the wage area based on the results of the preliminary survey.

(3) Using full-time, professional data collectors from outside the federal sector.

(4) Adopting separate wage-rate schedules for each trade skill (or family of related skills) rather than the single wage rate that is generally established under the current system. This system would establish wage rates for each trade based on the current situation in the labor market for that trade. Wage rates could be used to attract those skills for which valid shortages exist. Skills in excess supply would not benefit from high wage rates in skills in which they cannot compete.

[1]The study team considered briefly the possibility that the wage differential might somehow be justified by greater labor productivity in the federal sector. No evidence could be identified to substantiate this possibility; it is likely that, if productivity is accurately defined and evaluated, no significant difference in productivity exists between private and naval shipyards. It is also possible that the retention of higher wages in naval shipyards might be desirable as a means of creating an elite work force (i.e., higher wages attract the higher skilled worker). The extensive analysis required to evaluate this possibility is beyond the scope of this study but could be included in the wage adjustment study proposed in Section B.3 above.

(5) Using a merit system for in-grade raises rather than the automatic step increases of the current system.

(6) Considering total compensation, including fringe benefits and intangibles such as job security, in establishing wage rates for each trade.

RECOMMENDATION

- DoD should evaluate the desirability of revising the Federal Wage System so the system can accomplish its stated objective of establishing comparability of wages paid to federal government and private sector employees.

C. NAVY-PRIVATE SECTOR RELATIONSHIPS

During the 1974 Seapower Subcommitte Hearings considerable time was devoted to discussing business relationships between the Navy and the private shipbuilding and repair industry. Most of the criticisms leveled at the Navy by representatives from private shipyards were in relation to new construction. Some of the comments and criticisms, however, may be applicable to repair work as well and are evaluated here. The ensuing discussion does not endorse or condemn the criticisms and comments of the private shipyard representatives. The emphasis is on what lessons can be learned from them.

1. Lack of Stable Market

This comment, lack of stable market, in fact represents a criticism of the nature of the shipbuilding and repair industry, which is characterized by wide cyclical fluctuations in work among the private shipyards. In the Seapower Hearings, however, this criticism was intended to apply to the Navy and the manner in which repair and overhaul work is placed in the private shipyards. The Navy awards contracts for overhauls only thirty days (or less) in advance of the start date for the work, thus possibly contributing to the lack of a stable market. This

short-lead-time situation was discussed in Chapter III and in Section A.1. above.

In recent years, the Navy has attempted to allocate approximately 30 percent of the total dollar value of its ship depot maintenance workload to the private sector based on the premise that this amount assures adequate capabilities in the private sector to meet projected peacetime and mobilization-base requirements. However, while the percentage of the total workload allocated to the private sector has been relatively constant, for a variety of reasons the number of ships overhauled has decreased.

The extent to which Navy work represents a stable workload for individual contractors will vary, depending on the capacity and capabilities of each contractor. Federal law prescribes formal advertising as the preferred method of procurement by government agencies. Although formal advertising is expected to remain the primary form of contracting, methods should be explored to increase lead-times for award of contracts. The success achieved by an individual contractor in obtaining his share of the market will be determined by the extent to which he is able to compete with almost 200 other private contractors who are eligible to bid on Navy work and his ability to underbid successfully, that competition.

In all cases, however, it is the responsibility of the private contractor, not the government, to obtain enough work to continue operations. Any action that can be taken by a contractor to develop capabilities to repair and install weapons on combatant ships and to perform combat systems integration and check-out will greatly improve his competitive position.

2. Increased Use of Negotiated Contracts to Direct Complex Jobs to the Best Qualified and Proven Private Shipyards

As pointed out in Chapter III, the Navy Repair Manual stresses the use of advertised procurement for depot level

shipwork. Under this form of procurement, contracts are generally awarded to the lowest bidder, since the burden is on the government to prove that bids are non-responsive.

This form of procurement, in most instances, is an effective means of increasing competition for Navy workloads. Advertised procurement procedures, however, may not be the best way to award contracts for the overhaul of complex vessels, because of the limited number of potential qualified bidders. First, private shipyards that have proven their ability to accomplish complex Navy shipwork may be underbid by other private shipyards that have had little or no experience in performing such work. Although performance by the winning contractor may prove to be entirely satisfactory, it is more probable that significant delays will be encountered. Second, small contractors, who are usually heavily dependent on subcontractors to accomplish an overhaul, may submit the low bid. Management talent of the small prime contractor is frequently overtaxed in trying to control work schedules. This places on the SUPSHIP a large part of the burden of monitoring the contract work. As a result, jobs are often completed late and the quality of the work is inconsistent.

One method of solving this problem is the use of negotiated procurement. A review of the seventeen ASPR exceptions to formal advertising, which permit negotiation, indicates that ASPR 3-216 "Purchases in the Interest of National Defense or Industrial Mobilization" would permit negotiation of a complex overhaul. This negotiation authority could be used to direct complex overhauls to a limited number of fully qualified private shipyards.[1]

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[1] In addition to this advantage, negotiated procurement may also provide incentives to these shipyards to make capital improvements to increase overall efficiency (see Section D.3 below).

The Navy has expressed an intent to request proposals on a multi-ship package of complex overhauls.[1] The proposals from private shipyards to perform such a workload package would be evaluated for technical aspects, availability of skilled labor, management ability, and manning levels to accomplish the job in the time allowed. This approach would result in negotiation with the selected private shipyard for the specific work packages under the authority of ASPR 3-216. We believe this approach to directing complex work to the best qualified shipyard is sound.

We recommend that the Navy pursue the multi-ship package approach for complex overhauls. Further study is required to develop and refine the procedure and to determine the number of private shipyards needed to satisfy forecast requirements. Strategic factors also must be evaluated in completing the provisions of the final program.

RECOMMENDATIONS

- DoD should make more use of negotiated procurement procedures, under the authority of ASPR 3-216, for maintenance work with the private sector.
- The Navy should pursue the multi-ship package approach to ship overhauls.

3. Lack of Use of Discretionary Authority by Naval Officials Assigned to Approve Work Performed in Private Shipyards

This comment was directed primarily toward Navy ship new construction, but it probably enters into repair work as well. Two factors must be considered in evaluating this comment:

(1) The large number of SUPSHIP personnel involved in making a contract change.

(2) The SUPSHIP contracting officer generally is the only person who can grant final approval to a contract change.

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[1]Based on discussions with NAVSEA representatives from the Industrial Activity Work and Resources Planning Division.

As described in Chapter III, the SUPSHIP offices are organized along lines of personnel and functional specialization. For example, these offices include planners and estimators, inspectors, and negotiators. Most of these specialists become involved if the contractor wishes or is required to effect a change or modification to a contract.

Dealing with so many people, together with handling work scheduling problems that generally result from having to stop work until the change is approved. is frustrating for the private contractor. This frustration is magnified by the fact that, in his work for commercial customers, the private contractor deals with one individual--the port engineer--who represents the commercial ship operator. Even in dealing with the Coast Guard, a single representative on the scene makes the decision as to the work authorized, although written reports of conditions requiring changes to approved work packages must be provided by the private contractor.

Some of the SUPSHIP offices employ one individual, a generalist known as a surveyor, to perform the functions of planner, estimator, and inspector (quality assurance tasks). Use of surveyors not only reduces the number of people who must deal with the contractor but also provides the opportunity to increase SUPSHIP effectiveness without increasing manpower. We recommend expanded use of surveyors in routine operations. We also recommend that the criteria for appointment as a surveyor be upgraded to require broader, more extensive experience.

In sum, expanded use of surveyors, who have been delegated limited authority as contracting officers, appears to offer important advantages in effective use of SUPSHIP manpower. The Navy should examine adoption of this policy to improve the overall accomplishment of shipwork assigned to private shipyards. This examination should include a review of the current $10,000 limitation on job orders that can be executed under this system.

In view of the present inflationary conditions, a higher dollar limitation may be desirable.

RECOMMENDATION

- The Navy should expand the use of surveyors, with limited contracting authority, to increase the efficiency of the SUPSHIP operations.

D. SHIPYARD CAPABILITIES AND CAPACITIES

1. Number of Shipyards Certified to Work on Nuclear Ships

Currently, all nuclear ship overhaul and repair is accomplished in the six naval and three private shipyards that are licensed to perform nuclear work. The required data were not made available by the Navy for an evaluation of the cost-effectiveness implications of the number of shipyards certified to perform nuclear work versus actual and projected nuclear workloads.

The question of establishing and maintaining the proper balance between the number of shipyards capable of working on nuclear ships and actual and projected nuclear workloads is of vital importance for two reasons:

(1) The apparently higher cost of nuclear work versus non-nuclear work.

(2) The projected increase in the number of nuclear ships.

The cost-effectiveness implications of these two considerations cannot be evaluated without extensive analysis. Nevertheless, because of the vital importance of the issue, we recommend this as a subject for follow-on evaluation. Among the questions to be answered are the following:

(1) Are the current numbers and mix of nuclear-capable shipyards optimum for current and projected workloads?

(2) What are the relative advantages of concentrating nuclear work in a few, dedicated shipyards versus spreading available work among several shipyards?

(3) Should additional shipyards be certified as a mobilization base?

(4) What are the implications for current ship maintenance policy and capability of the 1974 federal law requiring that all future large combatant vessels be nuclear powered?

AREA FOR FURTHER STUDY

- Examine the current and projected number of nuclear capable naval and private shipyards required to support the projected increased number of nuclear ships.

2. Naval Shipyard Modernization Program

The Naval Shipyard Modernization Program has been in existence for ten years, but only about one-third of the facilities objectives and about one-half of the equipment objectives have been achieved. Apparently, this program has been consistently under-funded. In addition, some parts of the program have not been implemented because of uncertainty regarding shipyards that might be candidates for closure.

Every naval shipyard the IDA study team visited had requirements to replace shops that were cramped, poorly laid out, and that contained obsolescent equipment. Most of the shipyards had additional drydock requirements. It is illogical to expect these shipyards to continue to be able to handle projected Navy workloads without capital investment to improve the facilities and equipment available for depot maintenance. In addition, as ships become larger and more complex, fewer private shipyards may have the capability to perform repair work on Navy vessels. This situation will place even greater workloads on naval shipyards.

Modern naval shipyard equipment and facilities are essential to cost-effective performance of ship depot maintenance workloads. The Department of Defense should support the implementation of a long-range naval shipyard modernization program.

Since it appears that DoD will be under constant pressure in the future to reduce manpower requirements, such a program should emphasize installation of labor-saving equipment to improve the current labor-capital ratio in shipyard repair operations.

RECOMMENDATION

- DoD should confirm the number of naval shipyards required to support projected workloads, establish specific modernization objectives for each shipyard, and approve budgets for funds to accomplish those objectives.

3. Providing Incentives for Private Shipyards to Increase Their Capability and Capacity to Accept Navy Shipwork

According to NAVSEA estimates (Figure 24, Chapter III), only a few private shipyards currently can handle the complex overhauls of major combatant ships. Consequently, overhauls for these ships are generally accomplished in naval shipyards. Most auxiliary ship overhauls and a large part of the other repair workloads are accomplished in private shipyards. The following factors indicate that this approach to allocating Navy ship workloads may not be appropriate in the future:

(1) The duration and total mandays required to overhaul combatant ships have increased so that a single ship now ties up a major part of a shipyard's facilities for a considerable time. (Section IV.C.1.)

(2) The size and complexity of major combatants are increasing so fewer yards can complete complex overhauls of these ships. (Section II.B.1.)

(3) Shipyard manpower ceilings limit the total workload that can be placed in naval shipyards. (Section IV.C.2.)

(4) The commercial shipbuilding and repair workload has increased. (Section VI.C.)

(5) There are important drydock limitations in naval shipyards. (Section II.B.)

One course of action available to the Navy to address the impact of these changes is to modify and increase the amount of work accomplished in private shipyards by providing incentives that will motivate the private ship repair industry to expand its capability and capacity. A primary deterrent to expansion in the private sector is the high degree of uncertainty in the volume and types of workloads projected to be assigned to this sector. As a result, any management action taken by the DoD to reduce this uncertainty will be an incentive for private industry to consider expansion. Such action could include the following:

(1) Routine distribution to all private shipyards of at least a three-year schedule of ships projected for assignment to the private sector. This information could be extracted directly from the overhaul schedules currently published for the Atlantic and Pacific Fleets. Each private shipyard could use this information to estimate its projected share of the work.

(2) More negotiated job orders under MSRC procedures (see Section C.2 above).

(3) Leasing of government facilities and equipment to private contractors as a part of negotiated job orders and long-term, "level-of-effort" contracts. (For example, an agreement to provide two overhauls per year for a specified ship type and number of years.)

(4) Use of more "captive" yards--private shipyards essentially dedicated to the accomplishment of Navy shipwork. (Electric Boat, Groton, is an example of such a relationship.) One approach to achieving such a relationship is to negotiate a level-of-effort, multi-year contract with a private yard currently having difficulty in maintaining a profitable share of the market. In exchange for a guaranteed workload (e.g., a given number of overhauls or mandays of repair), agreements for extended audit and inspection agreements could be obtained. Current MSRC procedures could be used to assign specific ships.

(5) Creation of investment incentives (tax credits, accelerated depreciation, provision to plow excess profits into facility improvements, etc.) based on the long-term expansion of the industry rather than

the immediate return connected with specific job orders. For example, the incentive program could emphasize the development of less labor-intensive repair techniques. In addition, the policy could focus on those yards that have the potential to develop capabilities and capacities critical to Navy requirements (e.g., overhauls of major combatants).

(6) Revise work package development to permit splitting work between private and naval shipyards. For example, perform drydocking and routine repairs in private shipyards and overhaul of complex combatant systems in naval shipyards (see A.2).

We believe that DoD should initiate action to implement the proposals in (1), (2), and (6) above. Actions outlined in (3), (4), and (5) require further analysis.

RECOMMENDATION

- The Navy should distribute to all private shipyards on the Master Ship Repair Contract List a three-year schedule of ships projected for assignment for depot maintenance work to the private sector; use more negotiated job orders under MSRC procedures; and revise work package development procedures to permit splitting work between private and naval shipyards.

AREA FOR FURTHER STUDY

- DoD should conduct a comprehensive study to identify ways to provide incentives for private shipyards to improve their capabilities to handle Navy depot maintenance work. Included in this study should be exploration of the possibilities of leasing more government facilities and equipment to private contractors, use of more "captive" shipyards, and provision of long-range financial incentives.

4. The Private Sector's Capability to Accomplish Projected Navy Ship Depot Maintenance Workloads

Navy ship depot maintenance workload projections contained in POM-77 were used to obtain some insight into the extent to which the private sector will be required to expand to accomplish

increased Navy ship workloads in the FY-76 through FY-81 time period. These workloads are summarized in Table 61, in productive shop manyears, based on the Navy allocation between organic ship depot maintenance facilities and the private sector.

Table 61. PROJECTED NAVY SHIP DEPOT MAINTENANCE WORKLOADS (Productive Shop Manyears)

Fiscal Year	Naval Shipyards[1]	Private Shipyards	Total Workload
1976	26,455	14,396	40,851
1977	30,264	13,719	43,983
1978	32,800	14,132	47,932
1979	33,642	15,324	48,966
1980	32,824	16,266	49,090
1981	31,908	16,207	48,115

[1]Does not include component re-work, fitting out and post-shakedown availabilities and military assistance program work. Includes work projected for Overseas Ship Repair Facilities (from 2-4 percent of each year's total).

Source: Annex D, Department of the Navy Program Objective Memorandum, FY 77-81.

The ship depot maintenance workloads developed in POM-77 exhibit overall increasing trends. Total workload peaks in FY-80 after a four-year buildup of approximately 8200 manyears. The largest single-year increase occurs in FY-78, when almost 4000 additional productive shop manyears are required to accomplish total Navy ship workloads.

The projected workload for private shipyards peaks in FY-80, after a three-year buildup of approximately 2500 manyears. The largest single-year increase occurs in FY-78, when approximately 1400 additional manyears are required. As pointed out in Chapter VI, total employment in the private shipbuilding and

repair industry grew at a rate of over 5000 per year during FY-73 and FY-74 and was projected to expand at the same rate in FY-75. Thus, the private sector would not be expected to encounter difficulty in increasing its productive work force by the small percentage required to accomplish the Navy POM ship depot maintenance workloads.

For purposes of discussion, two other workload alternatives were examined to see if the private sector could be expected to encounter manpower constraints if the Navy required that sector to accomplish a greater portion of the increased workload.

Private Shipyards Absorb The Total Workload Increase: This alternative assumes that naval shipyard manpower remains fixed, at the FY-76 level, over the time period shown. Under these circumstances, the entire increase in work over the FY-76 levels would have to be placed in private shipyards. As pointed out earlier, the largest single-year increase in total workload is approximately 4000 manyears, with an average annual growth of only 2000 per year. Once again, the private sector would not be expected to encounter difficulty in achieving these low buildup rates, except, perhaps, in areas where the shipbuilding and repair industry has a large share of total area employment.

Fifty Percent of Navy Shipwork to Private Shipyards: This alternative assumes that 50 percent of the total ship workload would be placed in private shipyards as opposed to the current 70/30 policy. Under this assumption, the amount of work that would have to be absorbed by private shipyards, over and above already projected increases, ranges from approximately 5500 manyears in FY-76 to approximately 8500 manyears in FY-79. Average annual growth for the entire period is over 7600 manyears. While this growth is somewhat greater than the growth experienced in the FY-73 and FY-74 time periods, it still represents only about 5 percent of current total private shipyard employment. Once again, with sufficient lead times and proper incentives, the private sector could be expected to achieve the required employment levels.

Having indicated that achieving the number of manyears required to accomplish three different levels of Navy workloads is not a significant problem, it must be pointed out that considerable difficulty could be encountered in achieving the required skill levels and mixes. Shortages already exist for many skills required by the private sector to perform overhaul of Navy combatant ships. These shortages are especially significant in the skills associated with maintenance of complex weapons and combat subsystems. For example, NAVSEA estimates that only 7 of 188 MSRC holders currently possess the necessary skilled labor to perform overhauls of large, complex combatant ships. Thus, unless the private sector is given adequate economic incentives and sufficient lead time to invest in long-term training programs, achievement of proper skill levels could be a major constraint on the capability of the private sector to accomplish increased Navy ship workloads.

Facilities are also severely limited at present in the private sector. The impact of these limitations must be a major consideration in efforts to program significant increases in Navy shipwork to be assigned to private shipyards. As discussed previously, the Navy already places its auxiliary type ships in the private sector. Thus, increased workloads would involve efforts to assign a larger number of combatant ships for which facilities are already limited. As with the skill problem, facilities do not represent an unsurmountable problem, given adequate lead time and investment incentives.

In summary, increasing employment levels in the private sector to accommodate reasonable increases in Navy shipwork should not pose a severe problem. Obtaining required skill levels and mixes and the construction of additional facilities would impose severe limitations, unless the Navy can provide sufficient lead times and economic incentives that will motivate private shipyards to invest in these areas. This is especially true if the Navy expects private shipyards to invest in hiring,

training, and facility and equipment acquisition programs that are applicable only to Navy ships. (Alternatives to provide the necessary investment incentives were discussed above in Section D.3.)

E. PLACING SHIP NEW CONSTRUCTION IN NAVAL SHIPYARDS

Prior to 1966, the naval shipyard complex had two primary missions, building new Navy ships and repairing and overhauling ships of the active fleet.[1] In 1966, the Navy established a policy of placing all Navy ship new construction in private shipyards.

A few years after the Navy established its new policy, the Merchant Marine Act of 1970 was passed. One result of this act was to increase the opportunities for private shipbuilders to build commercial ships for what they considered to be a reasonable profit. With these new opportunities available, some private shipbuilders reassessed the attractiveness of building ships for the U.S. Navy. As documented in the 1974 Hearings of the House Seapower Subcommittee, subsequent to 1970, some major shipbuilders decided that building ships for the commercial market was a better way to meet the objectives of their firms, including profit maximization, than building ships for the Navy.

This study has examined "factors affecting costs for performance of Navy workloads and potential for varying workloads in commercial and naval shipyards."[2] Although the primary emphasis in the study has been on ship depot maintenance, Chapter II reviewed factors relating both to new construction and to depot maintenance. Since both types of workload require similar facilities, equipment, and manpower skills, decisions on placement of ship new construction work can affect performance of ship repair and overhaul workloads.

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[1]All naval shipyards had the depot maintenance mission, but only selected yards performed ship new construction work.

[2]Par 3, Subtask II, OASD/PA&E Task Order PA&F-81, 5 August 1974.

In assessing possibilities to improve the cost-effectiveness of shipyard work, we have examined the question of whether the DoD should resume a policy of having some Navy ship new construction accomplished in naval shipyards. Clearly, the environment has changed since the Navy decision in 1966 regarding ship new construction. Although the DoD has recently studied a possible policy change, we believe further study is required.[1] Moreover, if other actions recommended here are taken, those actions could have an important influence on the variables that should be considered in such a study.

Following are some of the more important factors relating to performance of ship new construction in Navy shipyards. These factors will be discussed below.

(1) The cost of ship new construction in naval versus private shipyards.

(2) Governmental philosophy on performance of industrial workloads in government-owned and private-owned facilities.

(3) Availability of military-related industrial facilities in case of war.

(4) Cost-effective utilization of facilities determined to be required to support uncertain military contingencies.

1. <u>Reasons for Placing Some Navy Ship New Construction in Naval Shipyards</u>

There are a number of reasons for placing some Navy ship new construction in naval shipyards.

a. <u>Uncertainties Regarding the Availability to the Navy of Ship New Construction Capabilities and Capacities in the Private Sector</u>

The period 1970 through 1974 has demonstrated many of the uncertainties that face the Navy in attempting to use the private

[1]See the NAVSEA studies, *Feasibility of SSN/TRIDENT/DLGN New Construction in Naval Shipyards*, 4 February 1974 (Code Ships 0717); *AS/AD New Construction in Naval Shipyards*, 24 January 1974 (Code Ships 0717).

shipbuilding sector to fulfill all of its new ship requirements.[1] As indicated above, some private shipbuilding yards subsequent to 1970 have become more interested in commercial work primarily because of presumed greater profit opportunities.

It is appropriate for the private shipbuilding industry to seek the most profitable opportunities available. It is also possible that profit rates are lower on Navy contracts than those with commercial shipping firms. We did not analyze relative profit rates in this study and are prepared to accept the fact that commercial business may be more profitable.

Many factors other than profit affect the desirability of Navy ship new construction business for the private contractor. We have addressed some of those questions in other sections of this chapter. Far more research would be required, however, to draw firm conclusions on the overall desirability of Navy ship new construction business for the private contractor.

One conclusion seems self-evident, though, without extensive research. The Navy, as a critical component of the national defense structure, must have a reliable source for acquisition of new ships. It is in the public interest that new ships be procured at a reasonable price. If ships are procured from private industry, prices must include a suitable profit to the builder. The Navy must conduct its ship procurement programs within the framework of federal government institutions that change slowly and place constraints on how DoD procurements may be conducted. Thus, it can be assumed that major changes, such as authorization for significantly larger profit margins in one of the many major industries doing business with the government, will not be made quickly.

[1]The U.S. shipbuilding industry has in fact undergone significant changes since 1966, moving from underutilization, low growth, and little or no profit to prosperity and under-capacity, and finally to a period of slower growth, doubtful profits, and great uncertainty.

In view of the strong positions taken by private industry representatives in the 1974 House Seapower Subcommittee Hearings, we believe that there is uncertainty whether the Navy can depend entirely upon the private sector for all of its ship new construction requirements unless the Navy is granted new flexibility in its contracting procedures and financial authorizations. Specifically, the Navy could need considerable authority to enter into cost plus fixed-fee contracts or otherwise find ways to provide private contractors higher rates of profit to make Navy contracts at least as desirable as those in the commercial sector. There is considerable doubt whether the Navy can establish the necessary new contractual policies to make Navy ship new construction as attractive as commercial work to a sufficiently large segment of the shipbuilding industry to ensure that an adequate number of shipyards bid on Navy work. In view of this situation, it may be necessary to resume some ship new construction in naval shipyards to ensure that the Navy fulfills its future ship new construction programs.

b. Maintaining an Understanding of Industrial Functions and Appropriate Costs to Build New Ships

Shipbuilding technology undoubtedly will change as improvements are made in basic ship systems and the Navy seeks greater combat capability in its fleet. If no new ship construction is performed in naval shipyards, the Navy will become increasingly dependent on private contractors for information on basic features of new systems and industrial procedures necessary to build modern ships. The Navy will have less and less capability to prepare reasonable estimates of mandays required for given shipbuilding programs. This problem can become particularly acute for larger or more complex vessels that can be built by only a very small number of private contractors.

c. Reducing Change Orders on Ships Built in the Private Sector

One of the major complaints of private firms who build Navy ships concerns the volume of changes the Navy can unilaterally require on vessels under construction. Change orders have resulted in billions of dollars of claims on the Navy from private shipbuilders.

Prior to World War II, it was Navy policy to build the first ship of a series in a naval shipyard. When this policy was in effect, the Navy had an opportunity to incorporate many changes and refine new ship specifications prior to entering into contracts with private builders.

A return to this basic lead-ship concept could be an important step toward improved relations between the Navy and the private shipbuilding industry. Orders for new ships could be based on specifications that would be much less susceptible to change than under current procedures.

This conclusion is based on the assumption that in any complex building program many changes must be made to production plans before specifications are refined. Moreover, on any large complex weapon system, concurrent fabrication and assembly work is under way on subsystems. Changes are often required in these subsystems that in turn cause ripple effects on other subsystems and the basic "envelope" of the total system. On Navy ships, these changes as well as early basic combat capability changes may be best handled in the controlled environment of a Navy shipyard. Handling these changes with a contractor is a complex procedure, largely because of the basic characteristics of the contractual process itself.

d. Improved Navy Research and Development Capabilities

We believe the Navy should maintain an effective research and development program in industrial procedures for ship new

construction. A part of this effort should be directed toward developing new industrial facilities and methods for substitution of capital for labor in the shipbuilding industry. The labor-intensive character of this industry imposes severe limitations on the extent to which improvements can be made within current cost and time requirements to build ships.

If new construction is performed in naval shipyards, an in-house laboratory would be available for pursuing R&D efforts on industrial activities related to ship new construction.

e. Availability of Ship Construction Facilities in Naval Shipyards

Currently, four naval shipyards have capabilities to perform new construction. These capabilities range from the relatively modern, large-scale facilities at Philadelphia to the very limited capabilities at Portsmouth. After large investments of public funds, many of these facilities stand idle.

Until recently, the general view of the U.S. shipbuilding and repair industry was that considerable additional capacity was required. It is recognized that shipbuilding capacities are not interchangeable. Even if excess capacity exists to build small vessels, there may be a critical shortage of capacity to build large tankers. Nevertheless, if the U.S. shipbuilding and repair industry, naval and private, is viewed as a total system or total national resource, then, in the public interest, more effective use should be made of naval shipyard capabilities and capacities, particularly for new ship construction. More effective use of these facilities could result in a lessened requirement for new capacity in the private sector, much of which would be financed directly or indirectly by the federal government.

f. Availability of Ship Construction Facilities in Private Shipyards

Section VI.C.1 of this paper discussed shipwork demand projections to 1981, in both the naval and private shipyard sectors. In spite of recent uncertainties regarding demand for tankers, it appears that at least through 1979, there will be demands for increased new ship construction by both the Navy and commercial shippers.

In Chapter I, it was pointed out that only three private shipyards have the capabilities to build modern submarines and only one private shipyard is capable of building a modern aircraft carrier. On the other hand, MARAD had identified twenty-five private shipyards as shipbuilding yards. In 1974, only six of those yards were building ships for the U.S. Navy, but it can be assumed that with proper economic incentives other private yards would be willing to perform Navy ship new construction.

Regardless of whether sufficient capacity exists in the private sector to perform all Navy ship new construction (and we are not certain that this capacity exists, considering commercial opportunities), DoD should still consider placing some Navy ship new construction in the naval shipyards. We believe that the other reasons given in this section may be overriding in determining the placement of this new construction work.

2. Reasons For Not Placing Navy Ship New Construction in Naval Shipyards

During this study, we had an opportunity to review many documents and consult with numerous industry experts on naval and private shipyard operations. This research revealed that strong views exist among experts regarding the placing of shipwork in these yards. It appears that the greatest divergence of view exists with regard to whether some ship construction should be placed in naval shipyards. We found no one

who took the position that all new construction should be placed in naval shipyards.

Following are the major reasons advanced for not placing Navy ship new construction in naval shipyards and our comments on those reasons.

a. "DoD Should Not Build Weapon Systems Under Our Free Enterprise Economy"

As would be xpected, this view is held most firmly by members of the private shipbuiding and repair industry, although it is shared by many DoD personnel. Often, reference is made to OMB Circular A-76, 30 August 1967, which affirms the government's policy of relying on the private enterprise system except in those instances when it is in the national interest for the government to provide directly the products or services it uses. This circular does not require that all Navy ship new construction be placed in the private sector.[1] Rather, it stresses the need for placing workloads based on the most economical relationships and the need for the proper war-mobilization base.

Private shipyard representatives are following a rational economic policy in recommending that nc Navy ship new construction be placed in naval shipyards. Such a policy not only provides more business opportunities for the private sector, but also eliminates a countervailing force that can affect future business volume and profits. Business firms consistently attempt to eliminate the uncertainties of the competitive environment and move toward the more secure environment of at least some market control. It is well known that the federal government has long assumed a role of attempting to prevent a high degree of market control by one or a few firms.

[1]Furthermore, the Vinson-Trammell Act of 1934 requires that some ship new construction work be performed in the naval shipyards. Placing all of this work in the private sector requires presidential waivers of the requirements of the Act.

On the surface, it appears that placing all Navy ship new construction in the private sector merely transfers part of the work from government-operated facilities to the free enterprise sector. Presumably, this action means that many shipyards, operating in a competitive environment, will bid on the work and the Navy will receive the best possible price for its procurements. In fact, this is not true. As indicated earlier, only a relatively small number of private shipyards are capable of building complex Navy ships. This number may be reduced further when potential bidders have commitments for commercial or other Navy work that saturate their yards. Ship procurement history will indicate, therefore, that only a relatively few bidders are in position to bid on contracts for complex Navy ships, and often those bidders must build new, or modify existing, facilities to handle new contracts. Thus, the Navy is forced to accept the low bid from one of the few bidders who are capable of responding to the request for bid, or it must attempt to find some way of negotiating an acceptable price. In our view, this is not necessarily consistent with the tenets of the American free enterprise system. In fact, it may be quite inconsistent and contrary to the public interest.

We believe, therefore, that the objection to DoD performance of work comparable to that performed by private industry is not appropriate for Navy new ship procurements. We believe it is in the public interest for the Navy to have alternatives other than dealing with a relatively small producer market.

In this chapter, we have recommended some DoD actions that could increase the number of private shipyards willing and able to bid on Navy shipwork, including shipbuilding. We recognize, however, that DoD may find it difficult or impossible to undertake the initiatives necessary to cause substantial growth in the producer market for complex Navy ships. We have concluded, therefore, that it may be appropriate to expand this market by resuming ship new construction in naval shipyards. This

action would give the Navy greater assurance of being able to achieve its shipbuilding programs. It would also introduce an element of competitiveness into a producer market that tends to be monopolistic or at best oligopolistic. Morever, considering the dollar magnitude of Navy new ship programs, it would be very desirable for the Navy to have the opportunity through in-house work to develop capabilities to assess the appropriateness of bid estimates from the private sector.

b. "Costs to Build Ships in Naval Shipyards are Higher Than in the Private Sector"

Relative costs are among the most difficult factors to assess in conducting DoD programs. Many studies have been made to compare the costs of performing work in DoD depots and in private contractor facilities. We found no such study that is uniformly accepted as a valid comparative cost analysis.

One difficulty in assessing the validity of these comparative cost studies relates to whether the analysis compared costs based strictly on accounting records or if the analysis was extended to include indirect costs not reflected in those records. For example, a total system analysis of private sector costs would require that indirect costs associated with the contracting process itself be included. Problems also arise in determining whether marginal or average cost relationships should be considered. An average cost concept would require incremental workloads to assume a proportionate share of overhead costs. This is inappropriate if, for other reasons, a given industrial structure is already established and will be maintained. For example, if war plans dictate a need for eight naval shipyards, marginal concepts should be applied in determining costs of additional workloads in those yards. This logic also applies to the utilization of excess facilities available in large private shipyards currently performing commercial work.

An example of naval shipyard operations when new construction was performed in those yards demonstrates some of the difficulties encountered in comparative cost analyses. The naval shipyards operated under the "flywheel" system when they performed new construction. Under this system, repair work was given a higher priority than new construction. If the yard had a high-priority repair job to be done, workers were transferred temporarily from shipbuilding work to the repair job. The result of this system was that new construction in naval shipyards tended to cost more and took longer than comparable work in private shipyards.

What is often overlooked is the value of the flexibility of the "flywheel" system. An economic analysis might attempt to impute some value to this flexibility, whereas those values would not be shown on the operating statements of the naval shipyard. It is unrealistic to compare the costs of building a ship under this system directly with the costs of building a ship under another system.

The current federal wage system would probably cause total ship new construction costs to be higher in the naval shipyards than in the private sector. In a labor-intensive industry, it would be difficult for the naval shipyards to overcome the disadvantage of a wage structure roughly 15 percent higher than in the private sector.

In sum, we agree that real total costs of building ships in naval shipyards may be higher than in private shipyards, primarily because of differences in labor costs. Nevertheless, it may still be desirable to place some new construction in naval shipyards in view of the fact that other reasons set forth in the preceding sections are more important than the cost differential. Moreover, placing some new construction in the naval shipyards, in the long run, will tend to restrain cost growth for future Navy new ship procurements, regardless of where the ships are built.

c. "Availability of a Broader Industrial Base to Meet Possible Mobilization Requirements"

It has been argued that Navy shipyard work should be placed in the private sector so a broader shipyard industrial base will be available in the event of war. This argument is usually presented with regard to repair work rather than new construction. Nevertheless, some experts apply this reasoning to new construction as well.

This line of reasoning has little merit with regard to new construction. It is doubtful that current war scenarios hold that a relatively larger new ship construction capability would be critical to the war effort. Even if a "long conventional war" scenario became a reality, time should be available to expand existing facilities to meet new ship requirements.

Finally, it is not evident that the closing down of naval shipyard new construction facilities and establishing counterpart new facilities in the private sector would increase total capacities. This could only occur if naval shipyard facilities were retained as "warm base" industrial war-reserve facilities. In addition, the costs of retaining the naval shipyard facilities as a "warm base" must be added to the acquisition costs of Navy ships built in the private sector if we are to estimate the true total cost of alternatives. Even under the industrial reserve system, it can be assumed that over time it would become increasingly more costly and difficult to reestablish the naval shipyard new construction capabilities in the event of need.

3. Methods for Placing Navy Ship New Construction in Naval Shipyards

If a decision is made to place some Navy ship new construction in naval shipyards, it can be implemented in several ways. A number of possible alternatives are discussed below, each of which would require further analysis to determine the most

appropriate method. This analysis should consider factors such as the need to raise or remove current manpower ceilings; cost-effectiveness of the various alternatives; and shipyard mission priorities.

Alternatives *a* and *b* are appropriate only if a fairly sizable program, extending over a period of several years, is envisioned. Alternatives *c* and *d* are appropriate if the Navy is unsuccessful in securing from the private sector reasonable bids on a proposed ship new construction program. Alternatives *c* and *d* would also apply if the Navy decided to concentrate on construction of lead ships and to place follow-on ships in the private sector.

a. Dedicate One Naval Shipyard to New Construction

Under this alternative, a naval shipyard would be dedicated to new construction and would perform no ship repair work.

It is assumed that additional non-competing workloads, such as component repair, could be concentrated in this yard. In addition, ship research and development programs could be undertaken in conjunction with new construction.

The new mission of this naval shipyard would result in some changes in the mix of labor skills. As indicated in Chapter II, essentially the same skills are required for new construction and repair work, although the numbers of workers required by skill vary at different points in time during the construction and repair cycles. Work force mix problems, however, should not be major hurdles if sufficient time is allowed to complete the transition to the yard's new mission.

Since the Navy ship depot maintenance workload is programmed to increase over the FY-76 through FY-81 period, this alternative would require increased utilization of the seven depot-maintenance oriented naval shipyards or an increase in the percentage of work allocated to the private sector. Considering current naval shipyard utilization rates, it is

assumed that the seven yards could absorb additional workloads if current manpower ceilings are removed.

b. Reactivate One of the Recently Closed Naval Shipyards and Dedicate One Naval Shipyard to New Construction

This alternative is essentially the same as *a* above, except additional Navy organic capability would be provided to handle future ship depot maintenance workloads. Lifting of current manpower ceilings on the naval shipyards would also be required.

c. Perform New Construction in One or More Yards Under the Old "Flywheel" System

This alternative represents a return to the previous method of performing new construction in naval shipyards. Manpower ceilings would have to be lifted unless additional depot maintenance work was placed with the private sector.

d. Perform New Construction in One or More Yards But Separate the New Construction and Depot Maintenance Operations

Under this alternative, each selected naval shipyard, to the extent possible, would have two dedicated work forces. Both activities would be supported by some commonly used shops, but direct work forces would not be used interchangeably.

Manpower ceilings on the naval shipyards would have to be raised or removed, but all facilities would be more effectively utilized under this alternative.

RECOMMENDATIONS

- The DoD should initiate a new study to determine if Navy ship new construction should be resumed in naval shipyards.

F. SHIPYARD PERFORMANCE DATA

1. Routine Publication of Shipyard Statistics

a. Naval Shipyards

The *Statistics of Naval Shipyards (SONS)*, published quarterly by NAVSEA, is an excellent source of summary-level data about naval shipyards. Continued widespread distribution of this document provides shipyard management at all levels a comprehensive basis upon which to discuss and monitor naval shipyard performance. The addition of more information about individual ship availabilities would make this publication even more useful. We recommend that, as a minimum, the following additional data be published in the *SONS* at the end of each scheduled ship availability.

(1) Ship type and hull number, shipyard, and type availability.

(2) Short description of overall work package at the conclusion of the work definition conference as a baseline for tracking subsequent changes. Scheduled arrival and departure dates and direct manday and cost estimates developed to accomplish the total work package should be included.

(3) Matrix showing significant changes in dates, work package content, total direct manday estimate, and total cost estimate for at least three additional points in the availability (ship arrival, about midway in the availability, and ship departure).

All required data are available on a routine basis within *NAVSEA*.

b. Private Shipyards

No single source of summary-level data about the performance of private shipyards in accomplishing Navy workloads could be identified during this study. Publication and widespread distribution of such data would provide managers of ship depot maintenance at all levels the means to monitor private shipyard

performance on a routine basis. In addition, the analysis required to publish such a document would be a valuable step in the development of a comprehensive basis for performance comparisons among private and naval shipyards.

We recommend that NAVSEA publish a document, similar in concept to the current *SONS*, to provide statistical information about private shipyards. This document would consolidate information already available from various sources within the Navy and could be prepared so as to avoid publication of proprietary information. In addition to data about individual ship availabilities (as described above for ships assigned to naval shipyards), data on contractor responsiveness to work proposals, bid success, and potential for accepting additional Navy work could be incorporated. Specific content could be adjusted, as required, depending upon whether the work was advertised or negotiated. The primary source of most of the information would be the SUPSHIP offices.

RECOMMENDATIONS

- The Navy should include in the quarterly report, *Statistics of Naval Shipyards*, data concerning adherence to original schedule, mandays expended, and cost for each ship availability completed during the quarter.
- The Navy should publish a document, similar in concept to the *Statistics of Naval Shipyards*, that would provide comparable information on private shipyards.

2. Improved Cost Data Detail on Private Shipyards

In addition to the routine publication of summary-level data about the performance of private shipyards as described in the preceding section, more detailed information about actual private contractor performance should be available to the Navy. For example, lack of readily available detailed data

about the mandays expended and costs incurred was a major problem during this study in comparing the relative performance of private and naval shipyards. Despite objections from the private sector about excessive data requirements, the Navy should explore alternatives to improve the quantity and quality of data available. These data are required especially for complex overhauls and major conversions that require thousands of mandays and millions of dollars. Improved data, which could be used by the Navy both to evaluate current performance and as a basis for developing standards for future performance, on both negotiated and advertised work packages would provide a basis for improving the overall cost effectiveness of shipyard operations.

The DoD Instruction 7000.11, "Contractor Cost Data Reporting" (CCDR), 5 September 1973, provides the precedent for obtaining detailed data from private contractors for major acquisition programs. Similar procedures and dollar thresholds could be established for major overhauls and conversions such that data would have to be reported, by major work item and in standard format, on ships assigned to private shipyards. The provisions of DODI 7000.11 should be analyzed as one approach to obtaining detailed data from private contractors.

RECOMMENDATION

- DoD should improve the quantity and quality of cost and labor data available from private shipyards by adopting provisions similar to those in DODI 7000.11.

GLOSSARY OF TERMS

ALTERATION. Any change in the hull, machinery, equipment, or fittings that involves a change in design, materials, number, location, or relationship of the component parts of an assembly regardless of whether it is undertaken separately from, incidental to, or in conjunction with repairs. An alteration is designed to upgrade the capabilities of a ship.

ALTERATION SOFTWARE. Design, engineering, and technical services for the evaluation of a proposed work package, cost and feasibility studies, the scope for proposed work package, the documentation, drawings, and data required for the accomplishment of the specified work.

APPROPRIATION. A congressional authorization to spend from the Treasury for specified purposes. An "annual" appropriation must be spent or obligated for expenditure within the fiscal year for which it is made; a "continuing" or "no-year" appropriation is available until exhausted or until the purpose for which it has been provided has been fulfilled.

AUTOMATED DATA PROCESSING (ADP). Data processing/recording/manipulation performed by a system of electronic or electrical machines so interconnected and interacting as to reduce to a minimum the need for human assistance or intervention.

AVERAGE HOURLY EARNINGS EXCLUDING OVERTIME. Bureau of Labor Statistics (BLS) defines this as the total production-worker payroll for the industry group divided by the sum of total production-worker manhours and one-half of total overtime manhours. No adjustments are made for other premium payment provisions such as holiday work, late-shift work, and overtime rates other than time and one-half.

BEAM. The extreme width of the hull of a ship including projecting structures. (The widest part of a ship.)

BILGE. That portion of the underwater body of a ship lying between the flat of the ship's bottom and the straight vertical topside.

CAPABILITY. Availability of those resources (namely, facilities, tools, test equipment, drawings, technical publications, engineering support, trained personnel, and material) required to carry out a specific task.

CAPACITY. A quantitative measurement of capability usually expressed as the amount of direct labor manhours that can be applied within a specific industrial shop or other entity.

CHANGE ORDER. A unilateral order that compels the contractor to make a change in the job order work. A change order is issued when an agreement *cannot* be reached with the contractor as to the effect it has on the delivery date and price.

COMPREHENSIVE EMPLOYMENT AND TRAINING ACT (CETA). A public law designed to provide job training and employment opportunities for economically disadvantaged, unemployed, and underemployed persons, and to assure that training and other services lead to maximum employment opportunities and enhance self-sufficiency by establishing a flexible and decentralized system of federal, state, and local programs.

CONVERSION. A major upgrading of obsolescent ships that enables them to perform a new mission.

COST CATEGORY. A classification of costs according to direct and indirect.

COST CENTER. A control unit selected for the purpose of budgeting, accumulating, and controlling related costs. It usually consists of a natural grouping of machines, methods, processes, operations; is identified with single management responsibility; and is made up of elements that have common characteristics.

COST CLASSES. A uniform classification of significant and controllable costs designed to accumulate costs of overhead operations within a cost center by function, program, or object.

COST ELEMENT. A classification of costs according to labor, material, and "other."

CURRENT SHIP'S MAINTENANCE PROJECT (CSMP). Provides shipboard maintenance managers with a consolidated listing of deferred corrective maintenance with which to manage and control its accomplishment. The CSMP is the basic Navy Maintenance and Material Management (3M) tool used on board ship.

CUSTOMER ORDER. A request for work or services to be performed that identifies the work to be completed, the completion date, and the amount and source of funds to be charged for

the work, and that authorizes and identifies any government furnished material (GFM) related to the order. Acceptance of a customer's order by the activity is the basic source of authority to incur costs, perform work, bill, and ultimately be reimbursed for costs incurred.

DEFERRED MAINTENANCE. Maintenance that, for various reasons, cannot be completed at the time it is identified; e.g., beyond the capability of ship's force, cannot be accomplished while the ship is operating, or the parts or material required for the maintenance action are not available.

DEPOT (SHIPYARD) LEVEL MAINTENANCE. That maintenance performed in fixed industrial activities whose extensive shop facilities and equipment and skilled personnel permit the repair, modification, and overhaul of ships and their associated assemblies, subassemblies, and components. In addition, a shipyard manufactures parts that are not available and provides technical assistance to the using activities (fleet) and intermediate maintenance organizations.

DIRECT COSTS. All costs that are identifiable to and charged directly to specific customer orders.

DRAFT. The depth of water a loaded ship draws.

EFFECTIVENESS MEASUREMENT. Involves comparing performance against end objectives to determine how well an activity is accomplishing its goals.

EFFICIENCY MEASUREMENT. Involves comparing performance against some standard to determine how well an activity is utilizing available input resources to produce a given output.

EMERGENCY VOYAGE REPAIRS. Emergency work necessary to enable a ship to continue on its mission and that can be accomplished without requiring a change in the ship's operating schedule.

FEDERAL WAGE SYSTEM (FWS). Outlines procedures for federal wage-grade employees (blue-collar workers). The basic objective of this system is to align government blue-collar wages with those in private industry, but, unlike the system for general-schedule employees, the goal is to align wages within local areas. For this purpose, wage areas are designated and all wage workers in that area are paid according to the wage schedule authorized for that area. The schedules are reviewed annually, at different times during the year in different areas, by a Civil Service Commission designated agency, normally the federal agency with the largest number of employees in the area. Data on prevailing local private industry labor rates are analyzed and a new wage schedule is developed for that area.

FISCAL MANAGEMENT DIVISION (OP-92). A staff organization within the Office of the Chief of Naval Operations, Directorate for Naval Program Planning that is responsible for the development, coordination, and maintenance of an integrated financial management system, which provides maximum flexibility in applying resources to programs in achieving basic Navy policy objectives.

FITTING OUT AVAILABILITY (FOA). An availability at the shipyard designated as the fitting out activity to place on board the material specified in the ship's allowance list.

FIVE YEAR DEFENSE PROGRAM (FYDP). The FYDP summarizes the official approved plans and programs of the Secretary of Defense for components within the Department of Defense.

FLEET MAINTENANCE ASSISTANCE GROUPS (FMAGs). Organizations established under the functional sponsorship and support of each fleet commander as organizational components of existing intermediate maintenance activities. Two vital Navy objectives are met by the FMAG concept: first to achieve increased retention of career personnel; and second, to improve fleet material condition.

FLY-WHEEL CONCEPT. A method of performing ship new construction in naval shipyards by which the labor performing new construction is treated as a surge capacity available for assignment to higher priority repair work as needed and then returned to ship new construction upon completion of the repair work.

GENERAL EXPENSE CENTERS. Cost centers that incur costs to perform services in support of all cost centers of the activity.

GENERAL PLANNING AND PROGRAMMING DIVISION (OP-90). A staff organization within the Office of the Chief of Naval Operations, Directorate for Naval Program Planning that is responsible for the direction and coordination of the preparation and review of Navy program planning documents; the analysis of CNO decisions for budget and programming implications; and insuring that appropriate and timely actions are taken to support decisions with resources.

GENERAL-SCHEDULE EMPLOYEES. Federal civil service employees who are employed under the General Schedule System prescribed by public law. General-schedule employees are salaried, generally white-collar employees in the clerical, administrative, technical, and professional job categories.

GENERAL SCHEDULE SYSTEM. Outlines procedures for determining salaries for federal general-schedule employees (white-collar workers). The objective of the system is to retain comparability of federal white-collar salaries with those paid in private industry. These workers are paid according

to a single, national rate schedule. The schedule is reviewed annually and recommendations for adjustment are made based on the rates being paid for comparable work in private industry. The data on private while-collar wages are collected on a nationwide basis by the Labor Department, which submits a tentative pay proposal to the President for approval.

HULL. The frame or body of a ship.

INDIRECT COSTS. Elements of costs incurred as a result of operations performed continuously in support of accomplishment of work for all customers.

INTERMEDIATE LEVEL MAINTENANCE. Maintenance of the type performed by Navy personnel on tenders, repair ships, aircraft carriers, fleet-support bases, and Fleet Maintenance Assistance Groups (FMAGs). It normally consists of calibration, repair, or replacement of damaged or unserviceable parts, components or assemblies; the emergency manufacture of unavailable parts; and providing technical assistance to using organizations.

JOB ORDER. Authorization and direction for the performance of specific work for customers or process shops according to specifications or estimates. A cost-accounting identification for collecting and accumulating costs.

LABOR TURNOVER. The Bureau of Labor Statistics (BLS) defines "labor turnover" as the gross movement of wage-and-salary workers into and out of employed status with respect to individual establishments.

LAYOFFS. Suspensions without pay lasting or expected to last more than seven consecutive calendar days, initiated by the employer without prejudice to the worker.

LEAD AGENCY. The activity designated by the Civil Service Commission (CSC) to implement provisions of the Federal Wage System. Normally, it is the federal government agency with the largest number of employees in a given CSC-defined wage area. The Lead Agency plans and schedules the annual wage surveys, analyzes the survey data, and establishes wage schedules.

LONG-RANGE PLANNING SYSTEM (LRPS). Planning system used by NAVSEA to develop ten-year shipwork allocation plans on the basis of the following inputs: current short-range overhaul schedule; long-range defense plans; shipbuilding and conversion plans; and funding levels in Operations and Maintenance, Navy Appropriation (O&MN).

MAJOR DRYDOCKING FACILITIES. Activities engaged primarily in repair or reconstruction and having at least one drydock that can accommodate ships 300 feet in length or more.

These yards do not usually engage in new construction, but they can perform this work if required.

MAJOR SHIPYARD. A shipyard that has at least one building position, incline, side launching, or a building basin capable of accommodating a maximum ship size of 475 feet length-over-all (LOA) and a beam of 68 feet.

MAJOR TOPSIDE REPAIR FACILITIES. Activities having the capability to provide repair service to ocean-going ships (generally 300 feet in length or more) when the work can be accomplished without taking the ships out of the water. Many of these facilities lease pier space on a job basis or they send personnel and equipment to the ship.

MANPOWER DEVELOPMENT AND TRAINING ACT (MDTA) OF 1962, AS AMENDED. A public law requiring the federal government to appraise the manpower requirements and resources of the nation and to develop and apply the information and methods needed to deal with the problems of unemployment resulting from automation and technological changes and other causes of persistent unemployment.

MANUFACTURING EXPENSE CENTERS. Cost centers that perform services that are in support of the production cost centers.

MASTER SHIP REPAIR CONTRACT (MSRC). This contract (ASPR 16-503.1) establishes in advance the terms upon which the private contractor will perform repairs, completions, alterations of, and additions to vessels and parts thereof under the provisions of job orders issued by government contracting activities. MSRCs are awarded to private shipyards following their written request for award and affirmative determination by a Field Contracting Officer from the local Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP). The determination is based on an appraisal of the contractor's management, labor force, and facilities.

NAVAL SEA SYSTEMS COMMAND (NAVSEA). An organization within the Naval Material Command (NAVMAT) that provides active and reserve operating forces with appropriate guidance and support on technical matters concerning the operation and logistic support of naval ships, support systems and equipment, and associated ordnance and missiles. In addition, NAVSEA provides the active and reserve operating forces with depot level maintenance facilities (naval shipyards, ordnance stations, torpedo stations, and ammunition depots) whose extensive shop facilities and equipment and skilled personnel permit the repair, modification, and overhaul of ships and their associated assemblies, subassemblies, components, ordnance, and missiles.

NAVY INDUSTRIAL FUND (NIF). A revolving fund established to finance service-type activities necessary to support military forces. It finances a continuing cycle of operations with receipts derived from such operations in their entirety for use by the fund without further action by the Congress. Typical Navy industrially funded activities are the naval shipyard operations and naval aircraft rework facilities in the Naval Material Command.

NEW HIRES. The Bureau of Labor Statistics defines "new hires" as temporary or permanent additions to the employment rolls. These include people who have never before been employed in the establishment (except employees transferring from another establishment of the same company) and former employees not recalled by the employer.

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE FOR PROGRAM ANALYSIS AND EVALUATION (OASD/PA&E). Staff organization within the Office of the Secretary of Defense that directs or conducts resource allocation studies, provides fiscal guidance to the various services, evaluates the Program Objectives Memorandums submitted by the various services, and writes the Program Decision Memorandums.

ORGANIZATION (SHIPBOARD) LEVEL MAINTENANCE. Maintenance that is the responsibility of and performed by the ship's force on assigned equipment.

OTHER SEPARATIONS. The Bureau of Labor Statistics defines "other separations" as terminations of employment because of discharge, permanent disability, death, retirement, transfer to another establishment of the company, and entrance into Armed Forces for a period expected to last more than thirty consecutive calendar days.

OVERHAUL AND REPAIR. Work necessary to restore a ship or article to serviceable condition without change in design, materials, number, location, or relationship of the component parts.

PLANNING AND ENGINEERING FOR REPAIRS AND ALTERATIONS (PERA). A NAVSEA organization that is designed to improve the advance planning, integration, and control procedures associated with planning and engineering for repairs and alterations required for the overhaul of ships. The primary objective of the PERA program is to provide intensive management for the accomplishment of effective, efficient, orderly, and timely ship overhauls.

PREOVERHAUL TEST AND INSPECTION (POT&I). An inspection conducted by a team from a shipyard or a private engineering firm under contract to determine the material condition of the ship and recommend repairs.

PRODUCTION COST CENTER. Cost centers that are engaged primarily in accomplishment of production or a process that is for specific work for customers.

PRODUCTIVE RATIO. In general, the relationship between the quantity of goods and services produced (output) and the quantity of resources that were input to the production process to produce the outputs. The term is sometimes erroneously applied to various labor ratios (e.g., direct-to-total labor) that address input resources only.

PRODUCTIVITY. A broad concept that represents one of several approaches to measuring efficiency. Productivity expresses the relationship between the quantity of goods and services produced (output) and the quantity of labor, capital, land, energy, and other resources that produced it (input).

QUITS. Terminations of employment initiated by employees, failure to report after being hired, and unauthorized absences if on the last day of the month the person has been absent more than seven consecutive calendar days.

REGULAR OVERHAUL (ROH). The accomplishment of general repairs and alterations at a naval shipyard or other shore-based repair activity normally scheduled in advance and in accordance with an established cycle.

REPAIR SHIP. (See Intermediate Level Maintenance)

RESTRICTED AVAILABILITY (RAV). The accomplishment of specific items of work by a repair activity, normally with the ship present, during which period the ship is rendered incapable of fully performing its assigned mission and tasks because of the nature of the repair work.

SERIES CONSTRUCTION. A method of ship new construction in which a group (series) of ships of the same class is built on a staggered schedule without interruption.

SHIP ALTERATION RECORD (SAR). A separate record for each ship alteration. The SAR provides a brief description of the alteration, the ship class and hulls to which it applies, the purpose, reference drawings, what the alteration accomplishes, and in general terms what is to be done. It includes a bill of materials with cognizant codes, weight and moment data, and the basic alteration class drawings to be developed.

SHIP'S FORCE. Synonymous with ship's crew.

SHIP'S FORCE OVERHAUL MANAGEMENT SYSTEM (SFOMS). This system provides a means for all levels of the ship's force management to plan, schedule, and monitor all ship's force efforts in conducting an overhaul or restricted availability in a manner that is integrated with the total industrial effort.

SHIP'S MATERIAL READINESS DIVISION (OP-43). A staff organization within the Office of the Deputy Chief of Naval Operations for Logistics that is responsible for the initiation, development, and dissemination of policy concerning the maintenance, modernization, material readiness, and disposal of all vessels and service craft of the Navy. In addition, OP-43 has the responsibility of coordinating the efforts of the Operating Forces of the Navy and the Naval Material Command in carrying out its policies.

SHIPWORK. Work accomplished that can be identified to a specific ship by hull number.

SUPPLEMENTAL AGREEMENT. A bilateral agreement between the SUPSHIP and the contractor that specifies what additional work is to be performed under the contract, its effect on the completion date, and the contract price (these agreements may be priced, unpriced, or provisionally priced).

SYSTEMS ANALYSIS DIVISION (OP-96). A staff organization within the Office of the Chief of Naval Operations, Directorate for Naval Program Planning, that is responsible for providing the CNO with an independent cost-estimating and review capability and for conducting cost and economic analyses.

TECHNICAL AVAILABILITY (TAV). The accomplishment of specific items of work by a repair activity, normally with the ship not present, during which period the ship's ability to perform fully its assigned mission and tasks is not affected by the nature of the repair work.

TENDER. (See Intermediate Level Maintenance)

TIGER TEAM. Colloquial term for a shipyard or contractor team trained and equipped to make a specific complex repair or to install a specific alteration or alteration equivalent to a repair in an operational ship. The specific task is performed on a TAV basis and usually includes design, planning, procurement, installation, and sometimes testing and allowance-cost validation.

WAGE AREA. Civil Service Commission defined geographic area within which are found concentrations of federal wage employees in combination with concentrations of private enterprise employees. The geographical area is treated as a single unit for purposes of conducting annual wage surveys and fixing and applying federal wage rates.

WAGE-GRADE EMPLOYEES. Employees under the cognizance of the Federal Wage System, referred to as blue-collar or hourly workers, generally in the trade, labor, and craft job categories.

WAY (BUILDING). An inclined structure upon which a ship is built or supported in launching.